

BATHYMETRIC STUDY AT MALACCA RIVER USING COMPRESSED HIGH-INTENSITY RADIATED PULSE DEVICE



BACHELOR OF MECHANICAL ENGINEERING TECHNOLOGY (AUTOMOTIVE TECHNOLOGY) WITH HONOURS

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Faculty of Mechanical and Manufacturing Engineering Technology



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Bachelor of Mechanical and Manufacturing Engineering Technology (Automotive Technology) (BMMA) with Honours

June 2021

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

June 2021

DECLARATION

I declare that this Choose an item. entitled "Bathymetric Study At Malacca River Using Compressed High-Intensity Radiated Pulse" 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.



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 and Manufacturing Engineering Technology (BMMA) with Honours.

Date

Signature : Najiyah Supervisor Name : Najiyah Safwa Binti Khashi'ie 27/1/2022 **TEKNIKAL MALAYSIA MELAKA** UNIVERSITI

DEDICATION

Every difficult task necessitates both self-effort and the guidance of experts, especially those close to our hearts. First and foremost, I dedicate my endeavour to my dear and loving father and mother. A heartfelt thank you to my parents for their unwavering support and for being a pillar of strength during my ordeal. In addition, I would like to express my greates appreciation to my supervisor and co-supervisor for constantly guiding and advising me.



ABSTRACT

Bathymetry is the method can be used to conduct a hydrographic survey. The method itself already evolve from time to time. The traditional way of bathymetric survey is using a single rope and single point checked. Besides, it has a huge limitation where it only can check a single point at a time different from the modern method like using Light Detection and Ranging (LiDAR) or sonar. These kind of new method is more effective than the old method because there is no limitation of point checked. The new method produced wider data result and the resolution for the data also higher than the traditional way. Not only that, the modern method also easy to use and the data obtained more accurate. Hydrographic survey is very important to estimate or observe the underwater terrain for the specific survey area. Hydrographic survey also can be used to provide the underwater map where it allows us to determine what is and is not safe, seafloor mapping is an important technique for regulating underwater resource exploration, extraction, and equipment. Other than that, bathymetric survey assist in ensuring that ships can manoeuvre safely and that human-made structures on the ocean floor are secure. Every bathymetric survey need a tool to ensure the study is successfully done. As this research is using the Smart Deeper Sonar device where this device is using the Compressed High-Intensity Radiated Pulse to transmit the sonar frequency. This device also has a built-in Wi-fi where we can connect our smartphones or other device to tracke the data from the device. The study area is Malacca state. Thus, this study is focusing on producing the bathymetry maps for the Malacca River and the accuracy of Smart Deeper Sonar Device.

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ABSTRAK

Batrimetri adalah satu kaeadah yang digunakan untuk menjalankan kajian hidrografi. Kaedah ini telahpun berkembang dari masa ke masa. Kaedah tradisional bagi menajalankan batimetri adalah dengan menggunakan satu tali dan satu titik kajian sahaja. Oleh itu, ia mempunyai suatu had kerana ia hanay boleh digunakan untuk memeriksa satu titik paada satu-satu masa sahaja. Berlainan dengan kaedah lama, kaedah moden seperti "Light Detection and Ranging" (LiDAR) atau sonar dapat memeriksa lebih daripada satu titik dalam satu masa. Bukan itu sahaja, data yang dihasilkan oleh kaedah moden adalah lebih meluas dan data yang dihasilkan juga beresolusi tinggi. Selain itu, data yang diperolehi melalui kaedah moden juga lebih tepat berbanding kaedah lama. Kajian hidrografi sangat penting untuk menganggar atau mengkaji bentuk muka bumi bawah air bagi sesuatu tempat. Kajian hidrografi juga digunakan untuk menghasilkan peta bawah air diamana peta ini boleh digunapakai untuk menentukan tempat tersebut selamat atau tidak. Pemetaan bawah air juga amat penting bagi menentukan keselamatan pergerakan keluar masuk kapal serta keselamatan pembinaan bawah air.setiap kajian batimetri memerlukan suatu alat bagi membolehkan kajian dapat dijalankan dengan jayanya. Dengan itu, kajian ini menggunakan alat "Smart Deeper Sonar" dimana alat ini menggunakan radar bagi menghantar frekuensi sonar ke dalam air. Tambahan pula, alat ini mempunya Wi-fi yang membolehkan pengguna untuk menyambungkan telefon pintar atau alatan pintar yang lain kepada alat ini untuk merekod data secara terus. Tempat kajian bagi projek ini adalah di negeri Melaka. Oleh itu, kajian ini memfokuskan untuk menghasilkan peta bawah air bagi sungai Melaka dan fungsi serta ketepatan alat "Smart Deeper Sonar". ونيؤم سيتي تيكنيكل مليسيا ملاك

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LIST OF SYMBOLS AND ABBREVIATIONS

ТМ	-	Trademark
CHIRP+	-	Compressed High-Intensity Radiated Pulse
LiDAR	-	Light Detection and Ranging
LADAR	-	Laser Detection and Ranging
3D	-	Three Dimensional
SLS	-	Selective Laser Sintering
2D	-	Two Dimensional
m	-	Meter
mm	-	Milimeter
GPS	-ST	Global Positioning Sensor
	IL TEKN	
	المك	اونيۈم,سيتي تيڪنيڪل مليسيا م
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CHAPTER 1

INTRODUCTION

1.1 Background

An overview of the river, its use, and how to preserve it are all covered in this chapter. Besides, this report will generally discuss bathymetric analysis, including the project's core concept, the problem statement, objective, scope, and the expected result.

1.2 Project Overview

The river is a natural water supply for a human ever since, and it is God's creation. Therefore, the water supply becomes an essential component of life for most creatures. If there is a shortage of water, the most creature will die. Moreover, water plays a crucial role in humans. For instance, water is needed to deliver nutrients. Not only that, but it also assists in converting food to energy. As a result, water supply has the potential to sustain human life quality.

UNIVERSITI TEKNIKAL MALAYSIA MELAKA Throughout this project, there will be an analysis of underwater depth or known as

Throughout this project, there will be an analysis of underwater depth or known as bathymetry. This analysis helps to create an underwater map by using the data obtained through the research. Meanwhile, a bathymetry chart is generally designed to assist in the protection of surface or subsurface navigation. It typically displays seafloor relief or terrain as contour lines and selected depths and surface navigational detail. Initially, bathymetry only uses depth sounding to determine the ocean's depth (Gao, 2009). The earlier technique of bathymetry is using a rope or cable over the side of a ship. Nonetheless, this method is inefficient since it only tests the depth of one point at a time, besides the ship movements and winds, which cause the rope to drift out of the line and inaccurate. Today, a bathymetric survey usually used an echo sounder mounted to the boat (Kapoor, 1981). The echo sounder sends a signal of sound downward to the seafloor, and when it reaches the bottom of the seafloor, the signal will be sent back to the transponder. Ecologists use remote sensing Light Detection and Ranging (LIDAR) or Laser Detection and Ranging (LADAR) system in bathymetric study. This type of system is more advanced than the echo sounder system. It uses sound or light speed transmission travel through the water.

1.3 Problem Statement

Malacca river, which flows through the middle of Malacca City, is well known for its river cruise. The length of the Malacca River is about 40 kilometres, originated from the Tampin river and Batang Melaka river. Back then, the European seafarers once called the Malacca River the "Venice of the East". These days, the Malacca River has been a popular tourist attraction because of the river cruise. The river cruise is a 45-minute round trip and covers 9 kilometres. It will be a main attraction of Malacca if the river is well maintained.

The problem statement that will be mainly focused on here are:

- a) There is no bathymetry study done that maps the depths and shapes of underwater terrain to illustrate the land below for Malacca River.
- b) The shallow river depth points that could present significant risks of boat accidents are unknown (Fowler and Sørgård, 2000).

1.4 Project Objective

The main objective of this project is to estimate the depth and the riverbed of the Malacca River. In detail, the project objectives are as follows:

- a) To perform a hydrographic survey on the riverbed of the Malacca River by using a Compressed High-Intensity Radiated Pulse (CHIRP) device.
- b) To study the functionality of CHIRP+ whether it is helping to conduct a bathymetric study

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1.5 Project Scope

This project scope was shown below:

- a) The accuracy of the CHIRP+ device.
- b) Only focusing on the Malacca River

1.6 Expected Result

The expected result for this project is to produce an underwater map for the Malacca River and observe the significant risk and point where boat accidents could occur. Below is an example of the expected result for this project.



Figure 1. 1 (a) Colour shaded relief image of the composite multi-beam and Olex bathymetry dataset (Olex-MB). The dataset comprises Olex data across all shelf areas except within the multi-beam transects indicated. Data below 800 m depth are multi-beam data only, as Olex data coverage is very poor. The position of MAREANO video lines (each ca. 700 m long) is also indicated. The inset map shows one example of the difference in resolution/quality between shaded relief bathymetry generated from Olex data at 50 m (left) and multi-beam data at 5 m (right) resolution.
(b) Colour shaded relief image of Olex bathymetry data only, illustrating the extent and density of coverage. Note that the colour range of the bathymetry in (a) and (b) has been adjusted to emphasize features on the continental shelf (Bowers, 1979).

CHAPTER 2

LITERATURE REVIEW

2.1 Background

In this chapter, the gathering information related to this bathymetric survey from the previous articles or sources will be presented based on Figure 2.1. This project literature review will begin with a study on the Malacca River.



Figure 2.1 Flowchart of Literature Review

2.2 Malacca River

2.2.1 Introduction

Malacca is the southernmost state in Peninsular Malaysia. Malacca is divided into three districts: Alor Gajah, Jasin, and Malacca Central. According to (Ang Kean Hua, 2017), the Malacca River is defined by the watershed's 13 subbasins.

Although Malacca has only three districts, it has one reservoir. Durian Tunggal Reservoir is a 20-kilometre-square reservoir located between Alor Gajah and Malacca Central. It serves as a water supply for Malacca's residents. When a community's population increases, public services such as transportation, housing, lodging, drainage, and water supply expand, resulting in economic development and political change. On the other hand, cultural and social ties were strengthened, which benefited the environment, particularly the Malacca River's water quality.

2.2.2 River Water Quality

The researcher has already studied Land Use Land Cover (LULC) changes in the Malacca River's water quality detection (Ang Kean Hua, 2017). The study determined the river water quality at nine different sampling stations, as shown in Figure 2.2; they stated that the data on river water quality were obtained from the Malaysian Department of Environment (DOE) (Ang Kean Hua, 2017).



Figure 2. 2 Sampling station and subbasins (Ang Kean Hua, 2017).

They assess river water quality using pH, temperature, electrical conductivity (EC), salinity, turbidity, and total suspended solids (TSS). Additionally, they assessed river water quality using the dissolved solids (DS), dissolved oxygen (DO), biological oxygen demand (BOD), chemical oxygen demand (COD), and ammoniacal nitrogen (NH3N) methods, as well as trace elements (i.e., mercury, lead, and zinc). The conclusion is drawn from the sampling data presented in Table 1. The study establishes a link between LULC and the quality of river water.

There are a few distinct land use classes, as illustrated in Table 1. In addition, the percentage of LULC varies over time, as shown in Table 2 (Ang Kean Hua, 2017).

Class name	Description
Vegetation	Including all agricultural and forest lands.
Built-up area	All residential, commercial, industrial, and transportation area.
Water	All water bodies (rivers and lakes).
Open space	All land areas that exposed soil and barren area influenced by a human.

 Table 2. 1 Classification of LULC.

	Total a	area and	l percen	tage			Magnitude change			
	A. C. C.		MC.	_						
Class name	2005		2009		2015		2001-2	2009	2009-20	015
LL		-						V		
	km ²	%	km ²	%	km ²	%	km ²	%	km ²	%
	83. A.									
Built-up area	196	29.3	245	36.6	337	50.3	+49	+7.3	+92	+13.7
	she	um	کل مل	í n	.4	aŭ ja	ر است	اونيةم		
Vegetation	271	40.4	202	30.1	221	33 🤤	-69	-10.3	+19	+2.9
U	NIVE	RSITI	TEK	NIKA	L MA	LAYSI	A ME	LAKA		
Water	138	20.6	97	14.5	30	4.5	-41	-6.1	-67	-10
Open space	65	9.7	126	18.8	82	12.2	+61	+9.1	-44	-6.6
Total	670	100	670	100	670	100	0	0	0	0

The Kappa test is used to ensure that classifications are accurate. The Kappa Test can account for all elements in the uncertainty matrix. This test was used to determine the calculation's accuracy using predefined producer and user-assigned ratings, which can be expressed as follows.:

$$K = \frac{P(A) - P(E)}{1 - P(E)}$$
 (1)

where:

$$A = \frac{(F-1)}{I} \times 100 \quad (2)$$

where A is a percentage of changes, F is first data, and I is reference data.

To increase the number of accurate analyses, each of the established four categories should receive a minimum of 50 points. As a result, the average classification accuracy in 2001, 2009, and 2015 was 89.51%, 88.49%, and 92.21 %, respectively, based on kappa coefficients of 0.87, 0.85, and 0.90. According to 2001 findings, the built-up area was 196 kilometres square (29.3%), agriculture was 271 kilometres square (40.4%), water was 138 kilometres square (20.6%), and open space was 65 kilometres square (9.7%). Only the built-up area and open space increased in 2009 by approximately 49 km² (7.3%) and 61 km² (9.1%), respectively, to equal 245 km² (36.6%) and 126 km² (18.8%). On the other hand, agriculture and water were reduced by approximately 10% and 6%, respectively, resulting in total areas of 202 km2 and 97 km2, respectively. Finally, built-up areas increased by approximately 13.7%, totalling 337 km2. While rural land has increased by 2.9%, totalling 221 km². Despite this, open space areas have shrunk by 44 km2, totalling 82 km² (12.2%), and water coverage has decreased by 10%, or 67 km². As a result, a total area of 30 km2 is created (14.5%). As a result of the increasing LULC, the river water quality deteriorated. Numerous factors contributed to this issue.

2.2.3 Data Sampling

Following that, Table 3 demonstrates that eigenvalues identified seven PCs that are more significant than a single PC that accounts for 69% of variances. Positive dissolved solids, electrical conductivity, and salinity loadings, all associated with agricultural activities and contribute to nonpoint source emissions via surface runoff, account for 15.3% in principal component (PC) 1. Pesticides used on oil palm and rubber plantations and some residents' livestock husbandry practices contribute to the Malacca River's salinity contamination. PC 2 accounts for a total variation of 10.3% in turbidity and gross suspended solid loadings. Pollution could occur due to human activities such as dredging, water diversions, and channelization destabilizing the Malacca River. Increased land clearing for urban expansion and surface runoff, on the other hand, contribute to the erosion of road edges in suburban areas adjacent to rivers (Ang Kean Hua, 2017).

Following that, PC 3 demonstrated positive loading on BOD and COD, which can be attributed to anthropogenic sources, with a high probability of coming from sewage treatment plants as point sources of contamination. Positive zinc and iron loadings were detected with a 10% overall variance in PC 4 loadings. Zinc contamination occurs as a result of urban and rural areas' widespread use of zinc-coated metallic roofs. It can be mobilized into the atmosphere and rivers when exposed to acid rain or smog. Iron contamination occurs in most rural areas as a result of agricultural activities, whereas it occurs in urban areas as a result of industrial effluents. PC 5 demonstrated a favourable arsenic loading with an overall variance of 8.5%, indicating that contamination is highly likely to affect agricultural land (Ang Kean Hua, 2017) Positive E. coli and total coliform loadings are observed in PC 6 loadings with an 8.0 percent total variance, but negative dissolved oxygen loadings are observed. PC 7 demonstrated a favourable mercury loading with a total variance of 6.8%, which is strongly associated with industrial chemical wastewater, the majority of which occurs in the Malacca River's middle and downstream. As a result, the most likely sources of contaminants in physicochemical and biological characteristics are agricultural, domestic, septic tank, sewage treatment plant, animal husbandry, industrial, and open space activities. Finally, as LULC levels rise, river water quality deteriorates (Ang Kean Hua, 2017).



Category	Unit				Mean/SD					
1-20		SI	S2	S3	S4	S5	S6	S7	S8	S9
лч		6.95	6.71	6.60	6.69	6.73	6.74	7.16	6.79	6.71
hu	I	0.54	0.34	0.31	0.43	0.29	0.37	0.57	0.46	0.41
Tama	Ç,	28.16	28.39	28.10	27.83	27.69	27.72	28.47	29.12	28.43
durat	ر	1.39	1.62	1.49	1.50	1.33	1.27	1.10	1.70	1.09
C.al	70	15.58	3.22	1.38	0.19	0.04	0.04	15.89	0.22	0.04
Sal	20	10.62	4.84	2.65	0.33	0.03	0.02	11.69	0.19	0.03
Ca.		19675.85	669.08	751.91	149.84	131.26	94.81	21440.05	575.97	421.67
PC PC	mo/cm	15404.51	804.15	1153.24	128.93	84.43	38.87	17392.75	452.25	597.87
Tec	1200	87.22	50.44	92.31	137.89	172.25	168.11	103.11	38.25	110.61
001	1/gm	98.09	55.81	60.05	127.04	176.29	156.76	98.85	14.56	99.65
20	1200	11596.37	496.24	367.15	136.13	53.87	55.05	6342.73	741.55	102.86
57	1/Am	9874.23	547.70	488.24	168.28	23.44	22.50	9143.48	2557.64	115.34
Т,	NITTI	115.93	72.32	298.37	170.26	220.29	180.42	57.86	120.63	174.35
INT	OTH	137.47	75.14	356.98	196.22	227.55	156.13	61.15	146.48	191.67
u v a	1/2000	5.36	7.14	4.83	3.94	3.97	4.11	5.61	8.64	4.69
DUD	1/gm	3.42	3.49	2.37	1.82	1.59	1.45	1.86	1.82	2.35
	1.~	40.86	39.53	31.72	24.56	26.83	21.94	33.86	41.69	25.36
COD	Ilg/I	23.79	19.64	12.46	12.60	11.46	4.93	16.44	16.47	8.36
	/~~~~	3.03	3.17	3.94	5.26	5.82	6.04	4.21	4.35	5.96
DO	1/gm	1.61	1.54	1.74	1.32	1.11	0.95	1.25	2.43	0.74
NH NI	1200	1.91	2.64	1.54	0.42	0.32	0.38	1.95	3.64	0.48
N1 ² LINI	1/gm	1.95	1.68	1.11	0.33	0.27	0.33	1.86	2.17	0.26
A.5	1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
61	1/2111	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
На	1/0m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
gri	1/SIII	0.00	0.00	00.00	0.00	0.00	0.00	0.00	0.00	0.00
Cd	ma/]	0.00	0.00	00.00	0.00	0.00	0.00	0.00	0.00	0.00
	1/8111	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
r.	ma/]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	1/8111	0.00	0.01	00.00	0.00	0.00	0.00	0.00	0.00	0.00
Dh	ma/1	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
1.0	1/2111	0.00	0.00	00.00	0.00	0.00	0.00	0.00	0.00	0.00
7.0	1/2000	0.04	0.03	0.04	0.04	0.04	0.04	0.04	0.04	0.04
711	1/SIII	0.03	0.02	0.03	0.03	0.03	0.03	0.02	0.02	0.03
Це	ma/1	0.23	0.45	0.72	1.00	0.81	0.85	0.21	0.72	0.85
	1/2111	0.32	0.38	09.0	0.69	0.59	0.76	0.26	0.54	0.51
Total coliform	Count/100 ml	413219.44	308180.56	295641.67	372263.89	246772.22	280902.78	110611.11	153483.33	113047.22
		489224.47	253164.67	394028.86	665998.32	331636.34	304712.75	106139.77	89787.51	87121.27
E coli	Count/100 ml	73322.22	45211.11	26426.86	11952.08	8181.39	31202.78	14315.08	31331.94	22167.50
T. COII		60836.76	42416.73	31735.22	16765.82	7885.95	48253.61	16147.08	35706.19	33138.80
Tur means turbidity	; DS means dissolved	d solid; Con means	electrical cond	luctivity; Sal means	s salinity; Temp means tem	perature; DO me	ans dissolved oxyge	n; BOD means bio	logical oxygen dem	and; COD means
chemical oxygen de	mand; TSS means tc	otal suspended solid	ls; pH means a	acidic or basic wate	r; NH_3N means ammoniac	al nitrogen; E. co	oli means Escherichi	a colitorm; Coli m	teans coliform; As n	neans arsenic; Hg
means mercury; Cd	means cadmium; Ci	r means chromium;	Pb means lead	d; Zn means zinc; l	² e means iron; SD means st	andard deviation	; S1 to S9 means Sta	tion 1 to Station 9.		

 Table 2. 3 Result of data sampling (Ang Kean Hua, 2017).

Table 2. 4Pi	rincipal Componer	its data (Ang Keai	n Hua, 2017)
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	1	2	3	4	5	6	7
Turbidity (NTU)	084	.761	.020	.162	.154	087	040
Dissolved solid (mg/l)	.806	048	.016	087	.093	.111	021
Electrical conductivity (uS)	.924	.011	.045	034	120	.050	.003
Salinity (ppt)	.913	018	.010	014	.064	.031	.007
Temperature (C)							
Dissolved oxygen (mg/l)	127	.254	207	184	.051	636	095
Biological oxygen demand (mg/l)	070	154	.806	074	.089	.053	014
Chemical oxygen demand (mg/l)	.233	.186	.781	.087	005	.083	.041
Total suspended solid (mg/l)	.056	.816	061	005	181	184	033
Acidity/alkalinity (pH)	.454	009	.198	396	546	084	023
Ammoniacal nitrogen (mg/l)	149	291	.549	275	124	.385	301
<i>E. coli</i> (cfu/100 ml)	.113	133	.076	.000	.105	.679	047
Coliform (cfu/100 ml)	001	188	019	.178	.500	.602	.497
Arsenic (mg/l)	A .130	017	.217	124	.763	.048	155
Mercury (mg/l)	001	009	.068	065	064	013	.870
Chromium (mg/l)	079	.507	092	113	.008	.015	062
Zinc (mg/l)	.089	.080	.014	.855	.059	.056	.106
Iron (mg/l)	319	.023	056	.746	.018	008	173
Initial eigenvalue	3.297	2.797	2.357	2.061	1.856	1.821	1.535
% of variance	15.539	10.310	10.115	10.024	8.526	8.088	6.852
Cumulative %	15.539	25.849	35.964	45.987	54.514	62.602	69.455

Variable (unit)

component

Principle

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2.3 Pollution

2.3.1 Introduction

River water pollution has become a global problem in recent years. This issue is related to the growth of the human population and the expansion of development. As a result, pollution endangers human and ecological health, as well as the availability of safe drinking water. According to (A. K. Hua, 2017), the water surface is constantly polluted as a result of its proximity to wastewater disposal. As a result, a geographic information system (GIS) can be used to identify and prevent potential pollutant sources. Additionally, it can be used to combat water pollution. (A. K. Hua, 2017).

Malacca has been designated a UNESCO World Heritage Site. It has a long history of being a tourism-based economy. Additionally, human activities such as agriculture, livestock, manufacturing, commerce, and urbanization contribute to Malacca River pollution. This pollution problem should be resolved immediately. (Kean Hua, 2015).

2.3.2 Identifying the Source of Pollution L MALAYSIA MELAKA

Rapid development has resulted in various forms of pollution, most notably water pollution. Freshwater availability has been dwindling day by day. The United Nations estimates that 2.2 billion people lack access to safe drinking water. River pollution can originate from a variety of sources. According to the National Geographic Official Portal data, 70% of industrial wastes are dumped untreated into the water in developing countries, contaminating the available water supply. While over 99 million pounds (45 million kilograms) of fertilizers and chemicals are used each year globally, 2 million tons (1.8 billion kilograms) of human waste are disposed of in waterways every day. (A. K. Hua, 2017) There is compelling evidence that chemical waste was dumped into waterways. Among them is the scandal surrounding the Kim Kim river. Between 20 and 40 tons of chemical waste were dumped illegally into the Kim Kim river. According to the New Straits Times, the toxic waste was dumped into the river for years before March 2019. Additionally, Dr. Zaki Zainudin, a water quality modelling specialist, stated that he has been monitoring the river for nearly ten years. The action has transformed the river into a dumping ground since 2012. Even though residents had previously complained to authorities about the issue, no action was taken. Dr. Zaki Zainudin stated that as a result, the river is technically dead. It was a tragedy for the residents living near that river, and approximately 143 disaster victims were still receiving treatment in hospitals and required special attention. The Kim Kim River has been declared safe following several massive clean-up operations (Yap, Peng and Leow, 2019).

As a result of pollution, extensive research has been conducted to ascertain the source of the pollution. The result indicates that surface runoff from land clearing and earthwork activity, and wastewater discharged by manufacturing and agricultural industries. Additionally, domestic sewage, animal husbandry, mining, and wastewater discharged by manufacturing and agro-based industries can contaminate water resources, particularly rivers. Apart from that, the findings were associated with NH3N pollution and salinity, emphasizing pesticide use in agricultural operations such as oil palm and rubber plantations and animal husbandry (chicken, cow, and goat) in the Malacca River basins (Ang Kean Hua, 2017).

2.3.3 Recommendations for River Pollution

Monitoring data in the scientific literature for scientific reporting is purely academic in nature and has no practical application. As a result, public complaints and scientific studies receive scant attention from regulatory agencies and are frequently ignored or relegated to the backlog. Only extreme pollution incidents posing a threat to human health, such as the pollution of the Kim Kim River, would prompt regulatory agencies to take immediate action (Abdullah *et al.*, 1999).

In terms of scientific monitoring data reports, governing authorities should work closely with researchers to benefit the public. The government should sanction polluters. Alternatively, the Department of the Environment should keep a close eye on any illegal dumping of chemical waste into our waterways (river and drainage). Then, more stringent laws and regulations, as well as competent river management, can be implemented. As a result, once scientific confirmation of hazardous chemical contamination in our rivers is obtained, it is critical for Malaysia to implement the "Polluter Pays Principle." This principle states that those who cause pollution should bear the cost of eradicating it to protect human and ecosystem health (Yap, Peng and Leow, 2019).

2.4 Bathymetric

2.4.1 Introduction

Bathymetry's objective is to monitor the underwater topography and movement of deposited sediments and provide navigational aids. This data is critical for managing port facilities, dredging operations, and forecasting channel infill and sediment budgets. Bathymetry can be performed using two methods: conventional and modern (Philpot, 1989).

Traditionally, only vessel-based acoustic echo sounding is used. This technique is capable of generating precise point measurements or depth profiles along transects. Regrettably, it is constrained by inefficiency, prohibitively high costs, and unavailability. Additionally, environmental and technological constraints preclude its use in shallow coastal waters difficult to navigate, especially at low tide (Gao, 2009).

The modern method improves bathymetric prediction by combining shipboard and satellite data. A compensation model predicts this strategy with two crustal layers. This method suffers from a coarse horizontal resolution of 8 kilometres and a low accuracy of fewer than 300 meters. On the other hand, this method is more rapid and adaptable to various environments, including shallow coastal waters, clear rivers, and relatively clean riverine reaches in the upper reaches of estuaries.

2.4.2 Mapping

Bathymetry mapping is classified into two types. The first type of bathymetric mapping is non-imaging. It is also known as optical radar or laser radar, and aerial LiDAR is an example of it (light detection and ranging). Optical radar transmits brief bursts of laser light over a large area. When the pulses detect a surface, they will return the signal. Water depth is determined by the pulse's two-way travel time between the water's surface and the seafloor. After identifying the surface and floor reflection pulses, the time difference between the two pulses is used to determine the depth of the water. In the late 1960s, an airborne pulsed blue-green laser was used to demonstrate the capability of deciding water depths. However, it was not widely used until the global positioning system (GPS) was developed (Gao, 2009).

Optical bathymetry sensing is another method of bathymetry mapping. It is based on the concept of radioactive energy reflected from the water column as a whole. This method utilizes shortwave radiation in the blue and green spectrums. These spectrums have a high penetration level. As solar radiation passes through water, it is increasingly scattered and absorbed by water and in-water elements, resulting in a wide range of energy being backscattered and captured in remote sensing images. After removing variables from the atmosphere and water column, the power received at the sensor is inversely proportional to the depth of water. As a result, the strength of the returned signal indicates the depth to which solar radiation has penetrated—a technique known as bathymetric optical sensing, or passive remote sensing (Gao, 2009)

Despite the fact that these two systems work on separate principles, they both produce the same results where they monitor underwater topography and deposit sediments while also providing navigational support (Gao, 2009).

2.4.3 Bathymetry Chart

To create publication-quality bathymetric charts, marine ecologists currently rely solely on Geographic Information System (GIS) tools, or the graphical user interface supplied by GeoMapApp and Google Earth. These tools either require GIS experience or have limitations regarding the functionality, datasets, and analysis offered. (Pante and Simon-Bouhet, 2013). Learning about the bottom topography of the World Oceans is imperative for a wide variety of scientific research. As shown in Figure 2.2, few types of the chart are available in Bathymetric mapping.





Figure 2. 3 Examples of two and three-dimensional plots created using marmap tools. Left panel (A): Data from the NW Atlantic Ocean, showing the NE coast of the USA and the New England and Corner Rise seamounts chains. The blue line represents the position of two- (B) and three- (C) dimensional cross-sections, the red rectangle delimiting the area covered by the belt transect. The bottom left figure (D) represents the NW Atlantic data plotted with the wireframe function from package lattice [21], based on data imported with marmap. Right panel: map of Papua New Guinea and satellite islands (E; see text). The central figure (F) represents the results of a least-cost path analysis around the Hawaiian Islands. The bottom figure (G) represents the results of projected surface area calculations for the bathyal and abyssal areas around the Hawaiian Islands (Pante and Simon-Bouhet, 2013).

2.5 **Compressed High-Intensity Radiated Pulse**

2.5.1 **Single Beam Techniques**

Single-beam (SBES) and multi-beam (MBES) echo sounders are frequently used to determine depths. SBES is the most commonly used tool in port and harbour surveys, and when appropriately used in a well-planned and executed study, it will continue to yield reliable results. SBES measurements are taken solely as soundings directly beneath the transducer. The line spacing between survey lines is determined by the final product's size and resolution requirements. Perpendicular to the undersea slopes, survey lines run. SBES has a fundamental disadvantage in that it illuminates only a portion of the bottom. Additionally, the bathymetric data will be deficient in depths between survey lines.

Bathymetric models are created using Digital Terrain Models (DTMs) with a regular grid. DTM is "a digital representation of the seafloor's topography (bathymetry) in terms of coordinates and depths." (El-Hattab, 2014).



(a) Single-Beam

Figure 2. 4 The coverage of echo sounders (El-Hattab, 2014).
The data from multi-beam echo sounders provide unprecedented detail of the seafloor, laying the groundwork for geological interpretations and identifying ecologically significant underwater terrain. Additionally, using expert interpretation and modelling, full coverage multi-beam data enables scientists to close the gap between scattered video and sampling observations and create a full coverage map, frequently requested by management (Gao, 2009). The importance of multi-beam data is undeniable, but it necessitates an investment in gathering and data processing and administration capabilities. This technique's data is used to map benthic habitats, and it frequently employs automated techniques for acoustic ground discrimination and habitat interpretation, focusing on physical habitats.

2.5.2 Chirp Pulse Compression

The first widespread application of chirp pulse compression was in radar systems. Examination of linear frequency modulated pulses and several related signal types through data. Chirp pulse compression is used to increase the range or resolution. The signal correlation technique generates frequency-modulated pulses, whereas linearly modulated signals are frequently used. They are simple to fabricate, but their spectra are not well matched to the transfer function of the ultrasonic system (Pollakowski and Ermert, 1994) (Ghelfi *et al.*, 2012).

Additionally, this modulation scheme results in a reduction of the compressed pulses' side-lobe level. As a result, the complexity of the hardware used to generate the signals is reduced. Ultrasonic transducers exhibit band-pass behaviour and have a previous bell-shaped magnitude spectrum. As a result, unlike radar, it is impossible to assume a transfer channel with a constant transfer function (Pollakowski and Ermert, 1994).

CHAPTER 3

METHODOLOGY

3.1 Background

This chapter will discuss the methodology used in this project from the data acquisition, data processing, and 3D model Bathymetric Contour Map. A few steps based on Figure 3.1 need to be done to ensure this study's objective.



3.2.1 Study Area

The study area is located within the Malacca River watershed, from the Jalan Munshi Abdullah to the Jalan Laksamana. Thus, this study covers approximately 3.1 km of the Malacca River. These are critical points on the Malacca River, as this is the most heavily travelled route for private boats, tourist boats, and small boats.

3.2.2 Path Planning

In February 2021, before the start of this project, the Malacca River hydrographic survey was observed. Regrettably, there is currently no hydrographic survey of the Malacca River. As a result, each project requires path planning to ensure that everything runs smoothly. The path planning for this project is shown below.



Figure 3. 3 Milestone Chart for PSM 2

The Department of Irrigation and Drainage Malacca determines the survey area. They have granted permission to visit the survey area, which extends from the Cheng subbasins to the mouth of the Malacca River and covers an area of approximately 15 km. For PSM 2, this project will begin with data collection from each location survey. All data will be stored in a single CSV document and used with AutoCAD to create the bathymetry contour map.

3.2.3 Technical Specification

This study will be using a remote-control boat (Flytec 2011-5) and a compressed high intensity radiated pulse smart sonar device (Deeper Smart Sonar). The smart sonar device will be mounted to the boat to drag by the boat along the river. Both devices are shown in the figure below.



Figure 3. 4 RC Boat (Flytec 2011-5)



Figure 3. 5 Deeper CHIRP+ device

Flytec 2011-5 is a remote-control boat where the body is made from Acrylonitrile Butadiene Styrene (ABS) material. ABS is an opaque thermoplastic and amorphous polymer. ABS is a good quality of any other thermoplastic since it is durable and firm against strong wind and waves. ABS also gives the extraordinary outlook of the boat. Other than that, this boat also has double motors to provide extra power to the boat. It has been stated that the remote-control distance can reach 500 meters without any interference. It clearly shows that the signal is more stable than any other remote-control boat available in the market. Flytec 2011-5 also has a rechargeable high-capacity Lithium battery placed into the middle of the boat body to be more stable.

CHIRP+ stands for Compressed High-Intensity Radar Pulse. This device uses advanced sonar transmission to collect data. Therefore, it is not like a usual sonar frequency. A standard sonar sends one single frequency at a time so that the feedback will be minimal. Not only that, the clarity and the resolution of the sonar imagery are also limited. Different from standard sonar, CHIRP transmission sends continuous frequencies where it will be ranging from low to high. As a result, it provides a broader range of information, but it also can create much clearer and higher resolution imagery. This functionality shows that CHIRP has a better transmission signal than standard sonar transmission.

3.2.4 Smart Deeper Sonar Settings

Smart deeper sonar device (CHIRP+) uses a Compressed High-Intensity Radar Pulse system that transmits pulses of sound into the water and records the returned echoes as each sound pulse is reflected off objects in front of the objects. This device has three types of frequencies that can be used where the first one is narrow CHIRP. Narrow CHIRP transmits 675kHz with 7° of beam angles. The second type is Medium CHIRP, which sends a 240kHz pulse with a 20° beam angle. Finally, the wide transmission type transmits a 100kHz pulse from this device at the 47° beam angle. With a different kind of frequency giving another kind of target separation, the user has a variety of choosing which type of frequency they want to use.



Figure 3. 6 The beam angle and the depth of CHIRP+ can reach

This device can scan up to 100 meters, and its scan rate is up to 15 seconds. Other than that, the CHIRP+ device has a temperature sensor to observe the water temperature. It can be operated in -20°C to 40°C of water temperature. In addition, this device also supports Global Positioning System (GPS), so the user can track their usage of this device. CHIRP+ can be used for up to 6.5 hours with GPS is on and up to 8 hours with GPS is off. It also comes with fast charging technology where it is fully charged in 75 minutes only. Not only that, but this device also has a built-in wi-fi connection.

3.3 Data Processing

3.3.1 Fish DeeperTM App

Since this study uses a Smart Deeper sonar, the CHRIP+ device, it comes with an application used in a smartphone. The user can connect their smartphone to the device; thus, the user can straight away collect data through his smartphone.

By connecting the phone to this device, the user can determine the depression contour lines. It also can detect imagery of vegetation, weeds, or brush piles in the water. Other than that, it also helps to scan the drop-off and inclining or declining points beneath the water. This feature will help set or observe a topography map for the researcher. Not only mapping, but CHIRP+ also can determine the absence of lives under the water. This device can spot the different hardness of the waterbed depending on how hard the object is, and the data will be displayed in the Fish Deeper[™] application. The user can differentiate the waterbed by using colour and brightness. There is a colour range in this application, where purple (softest) to red (medium) to orange (medium-hard) to yellow (hardest).



Figure 3. 7 shows that the thickness of the lines representing the bottom of the water



Figure 3. 8 shows the hard bottoms will send back robust returns data

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CHAPTER 4

RESULT AND DISCUSSION

4.1 Background

This chapter will discuss the result of this project from the data processing, analysis, discussion, and outcome. Other than that, this chapter will discuss the correlation of the overall objectives for this project. Below is Figure 4.1, which shows the flowchart of chapter 4.



4.2 Designing

4.2.1 Sketching

The product is roughly sketched on paper, where Figure 3.14 shows the rough sketch for the end product. The design product acts as a clamp to mount the CHIRP+ onto the remote control boat. The product used a 3mm screw to clamp the device and



4.2.2 Measuring

To ensuring accuracy, the edges and corners are measured by using a vernier calliper. This process is done before the product is generated into the CATIA software.

4.2.3 3D modelling

Figure 3.15 depicts the design process, which includes using CATIA software to assist in the design of the mounting part. Part Design is the workbench that will be used. This workbench function creates 3D models using the last method, generative form design (GSD)





Figure 4. 4 Actual sketch using Catia software

4.2.4 Printing

Figure 3.17, the Farsoon SS 420P laser sintering equipment was employed in the printing process. Farsoon is a fast-growing 3D printing company based in Changsha, Hunan Province, China, specializing in machinery and materials research and manufacturing. Farsoon is the world's only additive manufacturing company capable of producing laser sintering machines and materials in a single location. This combination results in a fully integrated solution that delivers best-in-class performance. The SS 402P laser sintering system has been touted as having the fastest scan and boost speeds in the industry field.



Figure 4. 5 Farsoon SS 402P Laser Sintering System

4.2.5 Printing Process

The printing process is the process of fabricating a model of CHIRP+ clamp. Table 3.1 shows the printing process of the clamp. The material used for printing the product is Nylon FS3200PA.

No	Procedures	Pictures
1	The parts that need to be fabricated is	
	arranged in Buildstar Software. The	
	software have its own limitation of the	
	whic are 50cm	
	Whic are 50cm.	
2	The ratio of raw FS3200PA Nylon	
	material, recycled nylon that heated by	
	the machine and recycled nylon that	
	heated without machine were mixed is	Contract Will Fr
	2:2:1. These raw material mixed UNIVERSITI TEKNIKAL	MALABARA
	Machine	

Table 4. 1 Procedures of printing design

3	The mixed powder was poured into the powder container. The powder container then placed in the metal container	
4	The metal container was placed in the	
	SLS 3D Printing Machine. The	
	machine will fabricate the powder into	
	solid parts by lasering them. The	
	fabrication process will be conducted	
	for about 9 hours.	اونيوسيتي تيك
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5	The container was removed into the Modification Machine, and unwanted powder formed in part by breaking the undesirable and leaving the wanted part. The scrap and steel brushes are also used to help to clean it.	
6	The part is placed inside the Sand	
	Blasting Machine. The unwanted	
	critical part and edges that are still on the wanted part will be removed from the machine. The powder dust will be cleaned by using the air pressure.	اونور ست تنک
7	Lastly, the printed process of the	MALAYSIA MELAKA
	model was ready.	

4.3 Data Processing

4.3.1 Storage

The data obtained from the sonar device will be stored in cloud storage in the Deeper Apps, where it can be accessed anytime. Figure 4.2 shows the scan history, while Figure 4.3 shows the bathymetry data of the Malacca River (depth, sediments, and aquatic life)



Figure 4.7 Data obtained

4.3.2 Data Format

Data obtained from the scanning process has been transferred into an excel sheet consisting of longitude, latitude, depths, and time. Based on the data obtained, it can be used for contour mapping by using excel.

4.3.3 Scanning Process

The scanning process conducted at the study area using remote-control boat and CHIRP+ device. Figure 4.8 shown the scanning process to obtained the data for this research. The device is mounted at the back of the boat throughout this process.



4.4 Data Analysis

The data is separated into ten critical points of the river. The depth of the river determines the point.



Figure 4. 9 Location of scanning process

The combination of Deeper applications and CHIRP+ device is beneficial to produce bathymetry data. After the scanning process has been done, the application will illustrate the data into the phone. Therefore, the data can be monitored through the phone. The data consists of depths, river sediments, aquatic plants, and fish.



Figure 4. 10 Data Components

 Table 4. 2 Component details

No	Components
1.	The surface of the river
2.	Water level or depth of the river
3.	River aquatic plants
4.	Underwater sediment

The Deeper app also generates and saves a contour map from the bathymetry data. Despite the fact that the application displays a basic contour map, the contour lines indicating the relative slope of the underwater terrain are still visible.



Figure 4. 11 Close up on the contour lines



Table 4. 3 Contour Map



Table 4. 4 Data from the Deeper application

Point	Depth (m)	Pictures C C
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4.5 Discussion

This research conducted at the Malacca River, the exact location is at Jalan Panglima Awang, Kampung Pengkalan Rama Pantai, 75400 Melaka. The research of bathymetry is about scanning the underwater terrain for assisting in the protection of surface or subsurface navigation. Initially, this research focused on performing the hydrographic survey for the Malacca River and analyzing the shallow points that might be a danger for the river cruise boat. Also, this research is to find out the accuracy of the CHIRP+ device. The total scan area has covered about 534m of the river. The Deeper application will project the resulting scanning from the CHIRP+ device. Therefore, the result will be stored in cloud data, where it can be accessed all the time.

Based on the result obtained, the average depth for Malacca River is 2.2 meters, where it is sufficient to ensure the boat safely cruises through the river. A deeper spot also lets the river cruise boats travel through the Malacca River. However, the bathymetric cannot be produced accurately due to the lack of data. This problem occurred because the smart sonar device lost connection with the GPS, so some of the longitude and latitude coordinates disappeared from the data stored in the cloud storage. Therefore, having a strong signal from the phone is very desirable when using the Deeper software. Nevertheless, the data illustrated on the Deeper software has a high-quality picture that shows the terrain and the river's sediments. In addition, the data can be accessed on the website since the data has been stored in cloud storage.

The research data's obtained from this study will be given to Perbadanan Pembangunan Sungai dan Pantai Malacca for future development for Malacca River. The agency should be alert to the river's depth since it is a tourist attraction used for river cruise activity. Some shallow points might danger the tourist cruising on the boat. Every boat has minimum depth for it to float on the water. Thus, the river's depth needs to be concerned to prevent accidents during the river cruise session. Usually, the boat needs three feet minimum water depths of about 0.9 meters. Nevertheless, the minimum depth depends on the boat profile. Apart from that, the agency needs to monitor the river depth to ensure no accident will occur.

Aside from helping the agency, this research also allows the researchers or inventors to invent a product to improve the river quality, such as garbage traps. Those inventions need the river depth data since it needs the specific place and depth to place the product to ensure it will significantly impact river quality improvements. The smart sonar device will help determine the correct spot to place the product since it can scan the river's depth. As a result, this research is not only one-sided benefits.

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CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Background

This chapter will be the last section of this report and explain the conclusion for the overall chapter for this Bathymetric study for the Malacca River. This chapter will also discuss recommendations and restrictions while conducting the research.

5.2 Conclusion

The primary purpose of this study is to perform a hydrographic survey on the riverbed of the Malacca River by using a Compressed High-Intensity Radiated Pulse (CHIRP) device mounted on a remote-control boat. Throughout this project, the Deeper apps become fundamental for storing the data from the scanning process.

The remote-control boat (Flytec 2011-5) somehow helps ensure the project's flow runs smoothly. The remote detection range of the ship is around 200-300m makes it easier to scan the river. Nevertheless, the speed of this boat is relatively slow, and it cannot move against the river current. Even so, it can still complete the task.

CHIRP+ device or smart sonar works perfectly with the Deeper application to scan the river's sediments. It projected the water depth and sediments into 2D data. The data from the sonar device will be illustrated to display real-time data on depth, bottom contour and structure, vegetation, and aquatic life on the screen. The data quality shown is also superb, and it can be transferred straight into Microsoft Excel format, where it helps produce underwater maps. Deeper software helped analyze the data that can produce the bathymetry maps of the Malacca river. In addition, this software helped create, produce, and project the structure of the underwater sediments scanned by the sonar device for this project. The software also stores the data automatically after the scanning process is done.

The second purpose of this research is to find out the functionality of the CHIRP+ device whether it is helping to conduct a bathymetry study. This device works perfectly paired with the Deeper applications; it helps collect the data for the bathymetric study. Hence, the shallow river depth could present significant risks of boat accidents. Based on the result findings, the bathymetry map cannot be produced due to the lack of data. Therefore, the functionality of the smart sonar device is proven by the data obtained in the Deeper software. Next, the depth of the Malacca River is sufficient to ensure the boat safely cruises through the river. Thus, there is still a significant risk for the boat accident. Hence, Perbadanan Pembangunan Sungai dan Pantai Melaka needs to monitor the river depth.

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5.3 Recommendation and Restrictions

There is much room for improvement in the future for this research. The correct way to perform the scanning process is to set the checkpoints before starting the scanning process. After selecting the checkpoints, the scanning method is across from the right to the river's left at the checkpoint. This method can ensure that the data obtained is more accurate and detailed. Also, this research needs a water level sensor that can determine the actual depth of the river, such as an indicator to find out the device is accurate or not. The device is absolute during the scanning process.

Nonetheless, the device has a few flaws that may cause data to be inaccurate. First, the device needs a good signal to operate well. If the signal is low, the device will be lost the signal, and the GPS cannot detect the CHIRP+ device, so the data obtained will not have the longitude and latitude points. According to the device's website, the data obtained will state the latitude, longitude, depth, and time. However, the low signal will disturb the data-taking process.

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On the other hand, the signal is also essential to ensure the data uploading to the cloud storage runs smoothly. Else, the data will not upload to the cloud. Therefore, this research might have been done using another scanning device available on the market. Other than that, the remote-control boat used for this research is weak to cruise through the river's current. Thus, using the powerful boat is better to complete this research.

Due to the lack of time, the checkpoint cannot be set for this fundamental research, and the method used for the scanning process is also straightforward. Also, the signal from the phone also very low, which caused some of the data not to have the longitude and latitude point, where this problem made the information less accurate. The low signal has also become a huge problem for storing data on the cloud so that the data might disappear after the scanning process. Besides, the data obtained is not enough to create an accurate bathymetric map for the proposed area since the device lost connection and some data of the longitude and latitude disappeared. The connecting of sites of equivalent depth is required for bathymetric maps. For example, a circular form can identify an ocean trench with smaller circles inside it. Yet, the data obtained is insufficient to plot the proposed area's bathymetry map. Despite that, the data obtained is enough to complete this research.

Last but not least, for future improvement, the mounting clamp needs to be redesigned. The design used in this research is not good enough to mount the device and cruise against the river current. The design wobbles during the scanning process, and it will fall off the boat. Furthermore, it is staggering due to parallax error during the measuring process before designing the mounting clamp. Thus, a 3D scanner is needed to measure the boat to improve the product. Else, the design needs to be revised.

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APPENDICES

PSM 1 PLANNING GANTT CHART 2021														
MONTH	MA	MARCH		APRIL				Ν	ЛАҮ		JUNE			
ACTIVITIES	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Find Supervisor	Р													
Decide Project Title	S								М					
Chapter 1 - Introduction									Ι					
Chapter 2 - Literature Review									D S					
Research Setup	R	2							E					
Chapter 3 - Methodology	Ι	8					6		М					
Finalize the project experiment	Е						1	7	В					
Draft submission	F		-	2		23	10	ىىب	R	او ا				
Slide Presentation	Î ITIT	EKI	лк	 Δ.Ι	MΔ		ې si	ΔM	E	KA				
Final Report submission	N								K					
	G													
Presentation PSM 1														

PSM 2 PLANNING GANTT CHART 2021/2022														
MONTH		R		NO	VEMB	ER		DISI	JANUARY					
ACTIVITIES	1	2	3	4	5	6	7	8	9	10	11	12	13	14
PSM 2 IMPLEMENTATION	Р													
Discussion with Supervisor	S													
Designing Mounting	М													
Thesis for Hardware														
Scanning Setup								М						
Scanning Testing	- B							I						
Scanning Process	R	40						S						
Organize Data	Ι		NYA.					Е						
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Research Deliverable (PSM 2)	F							В						
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Chapter 4 and 5 draft submissions														
Chapter 1, 2, 3, 4 and 5 final submissions								A						
Submission Final Report								K						
Presentation PSM 2														



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