International Conference on
Ocean, Mechanical And Aerospace
Scientists And Engineers
OMAse 4th
November 6 - 7, 2017
Universitas Andalas, Padang, Indonesia

# ACCEPTANCE LETTER

No: 038/OMAse4-038/2017 18 October 2017

Dear Respect Prof/Dr/Sir/Madam,

Hendra Saputra, Sapto Wiratno S, Mufti Fathonah M, Didi Istardi, Ardian Budi K.A, Mir'atul Khusna Mufida, Jaswar Koto

Articles for the fourth OMAse Conference on Ocean, Mechanical and Aerospace -science and engineering, November 6 ~ 7, 2017, Universitas Andalas, Padang, Indonesia : (http://isomase.org/OMAse/index.php)

"Development of Automatic Identification System (AIS) for Vessels Traffic Monitoring in the Strait of Singapore and Batam Waterways"

I refer to the matter above.

I am pleased to inform you that the above-mentioned article had been accepted and Insya Allah, All accepted papers will be selected and proposed to be published in the following proceeding and journals:

1. Proceeding of Ocean, Mechanical and Aerospace -science and engineering- (POMAse)
   **(ISSN: 2443-1710) indexed by ISOMAse**
2. Journal of Ocean, Mechanical and Aerospace -science and engineering- (JOMAse)
   **(ISSN: 2354-7065, e-ISSN 2527-6085) indexed by ISOMAse**
3. Journal of Subsea and Offshore -science and engineering- (JSOse)
   **(ISSN: 2442-6415) indexed by ISOMAse**
4. Journal of Aeronautical -science and engineering- (Jase)
   **(ISSN: 2442-6407) indexed by ISOMAse**
5. International Journal of Environmental Research & Clean Energy (IJERCE)
   **(ISSN: 2502-3888) indexed by ISOMAse**
6. Journal Mekanikal (JM)
   **(ISSN: 2289-3866, e-ISSN 2289-3873) indexed by FKM, UTM**

On behalf of 4th-OMAse, I wish to express our gratitude for your full cooperation and contribution in supporting our continuous effort of maintaining the publication of high quality articles in our Conference

Best Regards,
OMAse 4th
November 6 - 7, 2017

Admin,
Fourth Conference of Ocean, Mechanical and Aerospace science and engineering (OMAse)
Website: http://isomase.org/OMAse/index.php
Email : sec.omase4@unand.ac.id or admin_omase@isomase.org

# INVITATION LETTER

No: IL-038/OMAse4-037/2017 20 October 2017

Dear Respect Prof/Dr/Sir/Madam,

Hendra Saputra, Sapto Wiratno S, Mufti Fathonah M, Didi Istardi, Ardian Budi K.A, Mir'atul Khusna Mufida, Jaswar Koto

To Whom it May Concern
We are hereby pleased to invite you as the presenter for a manuscript :

"Development of Automatic Identification System (AIS) for Vessels Traffic Monitoring in the Strait of Singapore and Batam Waterways"

on the 4th International Conference of Ocean, Mechanical and Aerospace -scientists and engineers- (OMAse), which will be held on 6-7 November 2017 at Universitas Andalas, Padang, West Sumatera, Indonesia

"*Toward Enabling New Technology for the Better Future*"

Best Regards,

Dr. Adek Tasri

Chairman,
The 4th International Conference of Ocean, Mechanical and Aerospace -scientists and engineers- (OMAse)
Website: http://isomase.org/OMAse/index.php
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# PROGRAM

OMAse 4th

November 6 - 7, 2017

**November 6-7,2017**

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UNIVERSITAS RIAU

| Room C | Monday, Nov. 6 | 14.00AM-15.30PM |
|---|---|---|
| Session Chair: Jaswar Koto | Mechanical Engineering Dept. Universitas Riau | |
| | | |
| 14.00PM-14.12PM | **Development of Drains made of Natural Fibers for Accelerate Consolidation in Soft Soil** | |
| | **Rudy Purwondho** | *BINUS University – Jakarta, Indonesia* |
| | **Burhanuddin** | *PT. Ekko Hejo – Bandung, Indonesia* |
| 14.14PM-14.26PM | **Development of Dynamometer Based Strain Gauge With Type Round Rod Single for Cutting Force Measurement on Lathe Machine** | |
| | **Dody Eko Novianto** | *Universitas Riau, indonesia* |
| | **Yohanes** | *Universitas Riau, indonesia* |
| 14.28PM-14.40PM | **Tool path optimation and cost analysis for manufacturing Processes of Master cylinder piston of motorcycle brake** | |
| | **Anita susilawati** | *Universitas Riau, indonesia* |
| | **Niko Atmadio** | *Universitas Riau, indonesia* |
| | **Heri siswanto** | *Universitas Riau, indonesia* |
| 14.42PM-14.54PM | **Development of Dynamometer Based Strain Gauge With Type Four Square Plate for Cutting Force Measurement on Lathe Machine** | |
| | **Fahru Rozy Sany** | *Universitas Riau, Indonesia* |
| | **Yohanes** | *Universitas Riau, Indonesia* |
| 14.56PM-15.08PM | **Conceptual Design of Natural Coastal Erosion Protection System** | |
| | **Nita Yuanita** | *Institut Teknologi Bandung* |
| | **Alamsyah Kurniawan** | *Institut Teknologi Bandung* |
| | **Paramashanti** | *Institut Teknologi Bandung* |
| | **Anasya Arsita** | *Institut Teknologi Bandung* |
| 15.10PM-15.22PM | **Development of Dynamometer Based Strain Gauge With Type Four Square Plate for Cutting Force Measurement on Lathe Machine** | |
| | **Novi Saldi Huayan Harahap** | *Universitas Riau, Indonesia* |
| | **Yohanes** | *Universitas Riau, Indonesia* |
| 15.25PM-15.37PM | **Hydrodynamic Analysis of COBRA Riser** | |
| | **Jaswar Koto** | *Universiti Teknology Malaysia, Malaysia* |
| 15.40PM-15.52PM | **Development of Automatic Identification System (AIS) for Vessels Traffic Monitoring in the Strait of Singapore and Batam Waterways** | |
| | **Hendra Saputra** | *Politeknik Negeri Batam, Indonesia* |
| | **Sapto Wiratno S** | *Politeknik Negeri Batam, Indonesia* |
| | **Mufti Fathonah M** | *Politeknik Negeri Batam, Indonesia* |
| | **Didi Istardi** | *Politeknik Negeri Batam, Indonesia* |
| | **Ardian Budi K.A** | *Politeknik Negeri Batam, Indonesia* |
| | **Mir'atul Khusna Mufida** | *Politeknik Negeri Batam, Indonesia* |
| | **Jaswar Koto** | *Universiti Teknologi Malaysia, Malaysia* |

# Development of Automatic Identification System (AIS) for Vessels Traffic Monitoring in the Strait of Singapore and Batam Waterways

Hendra Saputra,[a)*] Sapto Wiratno S, [a)] Mufti Fathonah M,[a)] Didi Istardi, [b)] Ardian Budi K.A,[b)] Mir'atul Khusna Mufida,[c)] Jaswar Koto,[d)]

[a)] *Ship Design and Construction Technology Study Program, Department of Mechanical Engineering, Politeknik Negeri Batam, Batam, Indonesia*
[b)]*Department of Electrical Engineering, Politeknik Negeri Batam, Batam, Indonesia*
[c)]*Department of Informatics Engineering, Politeknik Negeri Batam, Batam, Indonesia*
[d)]*Faculty of Mechanical Engineering, Universiti Teknologi Malaysia (UTM), 81310, UTM Johor Bahru*

*Corresponding author: hendrasaputra@polibatam.ac.id

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## ABSTRACT

AIS (Automatic Identification System) is an automatic tracking system used by ships and vessel traffic service (VTS) for identifying ship information by electronically exchanging data with other vessels, coastal station, and satelite. AIS can be used to monitor vessels traffic on a strait channel by detecting a large number of vessels and collecting the ships information related to ship static, dynamic and voyage information such as MMSI number, navigation status, rate of turn (ROT), ship speed, ship position, course over ground (COG), ship heading (HDG), time stamp, RAIM flag and radio status at once. On this paper we try to develop an AIS system for vessel traffic monitoring purpose in the Strait of Malacca especially in the Strait of Singapore and Batam Waterways as one of the world's most congested straits used for international shipping. The method of AIS system development are divided onto 2 stage. Firstly, AIS raw data sent by ships are recorded and decoded as ships information into an application at once. Secondly, the output of AIS decode is used into web based interactive visualization application to visualize the vessels traffic. The development of AIS system has been tested by running the AIS record, decode and web visualisation and shown that the system could be applied to vessel traffic monitoring.

**KEY WORDS:** *AIS (Automatic Identification System), Vessel Traffic Monitoring*, web based interactive visualization application

## NOMENCLATURE

| | |
|---|---|
| *AIS* | *Automatic Identification System* |
| *MMSI* | *Maritime Mobile Service Identity* |
| *IMO* | *Internationa Maritime Organization* |
| *VTS* | *Vessel Traffic System* |

## 1.0 INTRODUCTION

Automatic identification systems (AIS) is a system which has capability to provide information of ships and broadcast the information between ships and coastal automatically. AIS message are consist of static and dynamic information.The static information including ship name, ship MMSI, ship type ship size and current time and the dynamic information consist of ship location, speed, heading, rate of turn, destination and estimated arrival time. The Autonomously broadcasted of AIS is usefull on Vessel Traffic System (VTS) for monitoring traffic and intelligent maritime traffic manipulations such as ship tracking prediction and collision avoidance. In addition, additional radar system is used on VTS to control ship in and out at the port area.

Automatic identification systems (AIS) are designed to be capable of providing information about the ship to other ships and to coastal authorities automatically for ship 300 gross tonnage and above engaged on international voyages, cargo ships of 500 gross tonnage and upwards not engaged on international voyages and all passenger ships irrespective of size (IMO, 1998).

On this study, we try to develop an AIS system for vessel traffic monitoring purpose in the Strait of Malacca focused on the Strait of Singapore and Batam Waterways as one of the world's most congested straits used for international shipping. The AIS station on this study is located in the main building of Politeknik Negeri Batam (Batam Polytechnic).

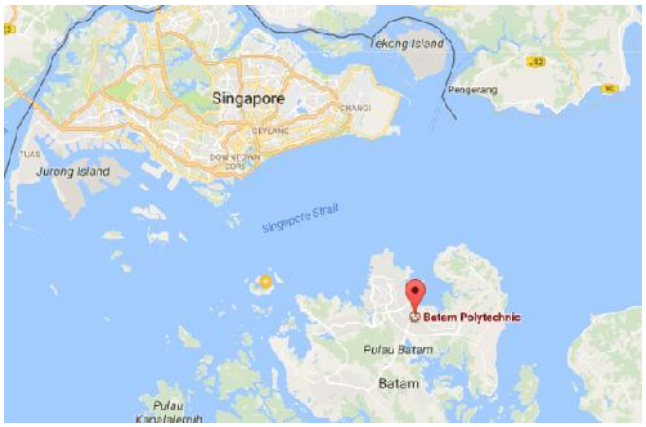


Figure 1: AIS Station (receiver) in Batam

The AIS system developed in this study is functioning to record & decode AIS message (NMEA Message 0183) which sent by ships and visualize the ships traffic through a web based platfrom. AIS message are recorded and decoded thorugh an application at once which built using LabView programme, whereas the output of AIS decode is used into web based interactive visualization application to visualize the vessels traffic.

## 2.0 AUTOMATIC IDENTIFICATION SYSTEM

The Automatic Identification System (AIS) is an automatic tracking system used on ships for identifying and locating vessels by electronically exchanging data with other nearby ships, AIS base stations, and satellites. A vessel carrying AIS equipment (AIS transponder) can communicate automatically to a neighbouring vessels and nearby station by VHF radio.

The requirements for AIS are outlined in Regulation 19 of Chapter V of the IMO (International Maritime Organization) Convention for Safety of Life at Sea (SOLAS). requires AIS Class A to be fitted on board ship related to international voyages of 300 gross tonnage and above which includes all seismic vessels, cargo vessel of 500 gross tonnage and upwards not engaged on international voyages and all passenger ships irrespective of size (IMO, 1998). In May 2014, EU (European Union) fishing vessels of 15 metres and over (but less than 18 meter) are required to fit and maintain in operation an automatic identification system (AIS) . Class B equipment is used by pleasure craft, fishing boats and other vessels smaller than 300 tons, but is not mandatory.

AIS is used by marine vessels in coordination with VTS to monitor vessel location and movement primarily for traffic management, collision avoidance, and other safety applications (Perez, 2009). The information provided by AIS can be displayed on a screen and is intended to assist vessel officers and also allow authorities to track and monitor vessel movements.

AIS system has capability to handle more than 2000 data per minute and updates every two seconds (Maciej, 2010). AIS system (transponders and receivers) use two VHF radio frequencies i.e 161.975 MHz (AIS1, or channel 87B) and 162.025 MHz (AIS2, or channel 88B). AIS is classified into 7 types: Class A, Class B, Base Station, Aids to Navigation (AtoN), Search and Rescue Transponder (SART) and AIS Transponder Specialist. Class A shipborne mobile equipment using SOTDMA (Self-Organized Time Division Multiple Access) technology that complies with IMO / SOLAS standards. Class B of AIS operate a different system to Class A transceivers. Class B operated by using Carrier Sense Time Division Multiple Access (CSTDMA) or SOTDMA. This type of AIS does not comply to IMO/SOLS standard, but comply to ISAF Cat OSR standards 1 and 2 (IMO, 1998).

The AIS class A will give information every 2 to 10 seconds while underway an every 3 minutes while anchoring. The information includes (Maciej, 2010):

a) MMSI number
b) Navigation status (as defined by COLREGS " at anchor"," under way using engine", " not under command")
c) Rate of turn – right or left, 0 to 720 degrees per minutes
d) Speed over ground – 1/10 knot resolution from 0 to 102 knots
e) Position accuracy
f) Longitude and Latitude
g) Course over ground
h) True heading

In addition, the information will be given by AIS Class A every 6 minutes includes:

a) MMSI number
b) IMO number
c) Radio call sign
d) Name of ship
e) Dimensions of ship
f) Reference point location
g) Types of position fixing devices
h) Draught of ship
i) Destinations
j) Estimated time of Arrival at destination

Class B messages have longer reporting intervals than class A when moving; the shortest reporting interval is 30 sec for equipment using carrier-sense TDMA (CSTDMA), and 5 second for equipment using self-organized TDMA (SOTDMA) moving faster than 23 knots. Static and voyage related data for class A equipment and the extended class B position report is transmitted once every 6 min in two slots (ITU, 2010)

Table 1: Class A Shipborne Mobile Equipment Reporting Intervals For Dynamic Messages

| **Ship's dynamic conditions** | **Nominal reporting interval** |
|---|---|
| Ship at anchor or moored and not moving faster than 3 knots | 3 min |
| Ship at anchor or moored and moving faster than 3 knots | 10 s |
| Ship 0-14 knots | 10 s |
| Ship 0-14 knots and changing course | 3 1/3 s |
| Ship 14-23 knots | 6 s |
| Ship 14-23 knots and changing course | 2 s |
| Ship >23 knots | 2 s |
| Ship >23 knots and changing course | 2 s |

### 2.1 AIS Message Encoding

AIS data is reported as ASCII data packets as a byte stream using the NMEA 0183 or NMEA 2000 data formats. NMEA defines many different sentences, two of which are normally used for containing AIS data named !AIVDM and !AIVDO. The content of both these sentences are identical (!AIVDM is transmitted, !AIVDO is on board). NMEA sentences are split into words separated by a comma. An example of a typical AIVDM data packet is:

**!AIVDM,1,1,,A,14eG;o@034o8sd<L9i:a;WF>062D,0*7D**

The meaning of each field is:

| | |
|---|---|
| **!AIVDM** | Tipe NMEA Message |
| **1** | Number of Sentences (some messages need more then one) |
| **1** | Sentence Number (1 unless it´s a multi-sentence message) The blank is the Sequential Message ID (for multi-sentence messages) |
| **A** | The AIS Channel (A or B) |
| **14eG;...** | The Encoded AIS Data |
| **0*** | End of Data |
| **7D** | NMEA Checksum |

NMEA encoding of AIS message using ASCII format where each of ASCII character on the message corresponds to 6 binary bits. There are 168 total of bits, occupying one AIVDM sentence. Every sets of bit (packet bitfields) represent pieces of informasi of the AIS message by converting its to decimal. The ASCII format for AIVDM/AIVDO representations of AIS radio messages have been set by IALA Technical Clarifications on Recommendation ITU-R M.1371.

```
2017/08/13 01:59:59.396,0,0,!AIVDM,1,1,,A,18I3=l0P00WKiJ40gU@00?vr28AT,0*09
2017/08/13 01:59:59.466,0,0,!AIVDM,1,1,,B,18lIwr?0007Jt>h0gSIP0:Jt00?W,0*50
2017/08/13 01:59:59.491,0,0,!AIVDM,1,1,,B,17tD6C0P00WM2KR0FLSLU?vr20ST,0*57
2017/08/13 01:59:59.546,0,0,!AIVDM,1,1,,B,37ld`VP00insF`P:pPIcKwfUoP96,0*3A
2017/08/13 01:59:59.596,0,0,!AIVDM,1,1,,B,18KcKL00007KkuP0gFJ3InLp0@Ad,0*17
2017/08/13 01:59:59.611,0,0,!AIVDM,1,1,,A,H8HswwQL5@E:1@5PV0UJ2222220,2*05
2017/08/13 01:59:59.651,0,0,!AIVDM,1,1,,B,18Htve`00f7LG`p0iFc<K?Rt0638,0*4B
2017/08/13 01:59:59.706,0,0,!AIVDM,1,1,,A,133vjB300I7JPs@0e4R5h58r80SM,0*36
2017/08/13 01:59:59.731,0,0,!AIVDM,1,1,,B,38KKw:5P0?7KQJH0c16<<0vv06gk,0*62
2017/08/13 01:59:59.761,0,0,!AIVDM,1,1,,B,18Ht?f0P02WL=rp0jcI3q?vr2<?4,0*03
2017/08/13 02:00:00.003,0,0,!AIVDM,1,1,,B,1815Ekh001WKh680`e50qP6r8<:`,0*2E
2017/08/13 02:00:00.023,0,0,!AIVDM,1,1,,A,18Htq?`001WKmMv0gNDCv68v0D>7,0*2B
2017/08/13 02:00:00.038,0,0,!AIVDM,1,1,,B,18Hs48PP007KdmB0fJhP0?vr0HAt,0*4E
2017/08/13 02:00:00.108,0,0,!AIVDM,1,1,,B,4h50Ko1v66A2NWL8wp0c@G700<59,0*56
2017/08/13 02:00:00.128,0,0,!AIVDM,1,1,,A,18HtTq00027KkM00gNm@nV>v0@30,0*18
2017/08/13 02:00:00.158,0,0,!AIVDM,1,1,,A,18Ht3M0000WJrNf0csTrVVHt2@31,0*11
2017/08/13 02:00:00.183,0,0,!AIVDM,1,1,,A,18Iq:t00027KlUV0gVLQWEFv0D?=,0*00
2017/08/13 02:00:00.208,0,0,!AIVDM,1,1,,A,19NSAc002@WKb3F0cUaB`28v0054,0*31
2017/08/13 02:00:00.238,0,0,!AIVDM,1,1,,B,1776590023WJvjJ0a8MAWQBv0LEr,0*78
2017/08/13 02:00:00.268,0,0,!AIVDM,1,1,,B,18Hu4JPP017KVj:0g650lA6t0638,0*19
2017/08/13 02:00:00.293,0,0,!AIVDM,1,1,,B,18HtWj8P1vWK>>p0c8?1=?vt2D<>,0*78
2017/08/13 02:00:00.308,0,0,!AIVDM,1,1,,A,38HuBch001nmh00;D:?Q3whTSP96,0*24
```

Figure 2: A fiew of AIS message (NMEA messsage) on observation

The first 6 bits of the payload (0-5) are the message type. There are 27 AIS messages types, but the most used in the wild are the position reports that can analyzed using ITU-R M.1371 standard. On this paper, we focused on type 1,2 and 3 message only. Type 1, 2 and 3 messages share a common reporting structure for navigational information, its called as Common Navigation Block (CNB) (Eric, 2016)

Table 2: Common Navigation Block

| Field | Length | Description |
|---|---|---|
| 0-5 | 6 | *Message Type* |
| 6-7 | 2 | *Repeat Indicator* |
| 8-37 | 30 | *MMSI* |
| 38-41 | 4 | *Navigation Status* |
| 42-49 | 8 | *Rate of Turn (ROT)* |
| 50-59 | 10 | *Speed Over Ground (SOG)* |
| 60-60 | 1 | *Position Accuracy* |
| 61-88 | 28 | *Longitude* |
| 89-115 | 27 | *Latitude* |
| 116-127 | 12 | *Course Over Ground (COG)* |
| 128-136 | 9 | *True Heading (HDG)* |
| 137-142 | 6 | *Time Stamp* |
| 143-144 | 2 | *Maneuver Indicator* |
| 145-147 | 3 | *Spare* |
| 148-148 | 1 | *RAIM flag* |
| 149-167 | 19 | *Radio status* |
| No of bits | 168 | |

The example of information in the AIS system as the result of decode of AIS message can be show on figure 3. The information gets from decode process are Tanggal (Date), Jam (time), Packet Type, Channel, AIS Type, Repeat Indicator, MMSI, Navigation Status, Rate of Turn, Speed Over Ground, Position Accuracy, Longitude, Latiitude, Course Over Ground, True Heading, Time Stamp, and Maneuver Indicator.

| Tanggal | Jam | MMSI | Nav Status | ROT | SOG | Long | Lat | COG | True Head | Time Stamp | Manuv .Indic |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 8/12/2017 | 23:59:59 | 563138000 | 0 | 128 | 0 | 103.93 | 1.2993 | 0 | -1 | 29 | 0 |
| 8/12/2017 | 23:59:59 | 56665000 | 15 | 0 | 0 | 103.75 | 1.2985 | 0 | -170 | 30 | 0 |
| 8/12/2017 | 23:59:59 | 538005800 | 0 | 128 | 0 | 104.21 | 1.3229 | -876 | -1 | 29 | 0 |
| 8/12/2017 | 23:59:59 | 525019290 | 0 | 0 | 4.9 | -126.8 | 19.019 | -1159 | -9 | 18 | 3 |
| 8/12/2017 | 23:59:59 | 56684000 | 0 | 0 | 0 | 103.04 | 1.290 | 871 | 206 | 26 | 0 |
| 8/12/2017 | 23:59:59 | 563013630 | 1 | 112 | 33.6 | -151.6 | -54.89 | -1528 | 65 | 1 | 0 |
| 8/12/2017 | 23:59:59 | 563035830 | 8 | 0 | 4.6 | 104.06 | 1.3477 | -915 | -207 | 30 | 0 |
| 8/12/2017 | 23:59:59 | 205501000 | 3 | 0 | 2.5 | 103.56 | 1.2307 | 1472 | 154 | 27 | 0 |
| 8/12/2017 | 23:59:59 | 565641000 | 5 | 128 | 5 | 103.88 | 1.1747 | -975 | -1 | 31 | 0 |
| 8/12/2017 | 23:59:59 | 563023800 | 0 | 128 | 0.2 | 104.03 | 1.3838 | 596 | 1 | 29 | 0 |
| 8/13/2017 | 0:00:00 | 538006091 | 0 | 0 | 0.1 | 103.03 | 1.1115 | 230 | 3 | 29 | 0 |
| 8/13/2017 | 0:00:00 | 563034430 | 8 | 0 | 0.1 | 103.95 | 1.2963 | 1015 | 196 | 31 | 0 |
| 8/13/2017 | 0:00:00 | 563004450 | 0 | 128 | 0 | 103.92 | 1.2675 | 0 | 1 | 29 | 0 |
| 8/13/2017 | 0:00:00 | 5250012 | 1 | 248 | 30 | -200.2 | 15.725 | -1215 | 227 | -32 | 0 |
| 8/13/2017 | 0:00:00 | 5250012 | 0 | 62 | 28.5 | 218.61 | 0.32 | 0 | 0 | 0 | 0 |
| 8/13/2017 | 0:00:00 | 563029220 | 0 | 0 | 0.2 | 103.94 | 1.2966 | 218 | 199 | 31 | 0 |
| 8/13/2017 | 0:00:00 | 563020660 | 0 | 0 | 0 | 103.75 | 1.1996 | -1382 | 204 | 30 | 0 |

Figure 3: Example of sorts AIS information on the observation

### 2.2 MMSI (Maritime Mobile Service Identity) Number

Maritime Mobile Service Identities (MMSI) are nine digit numbers used by maritime digital selective calling (DSC), automatic identification systems (AIS) and certain other equipment to uniquely identify a ship or a coast radio station. MMSI are regulated and managed internationally by the International Telecommunications Union in Geneva, Switzerland. The MMSI format and use is documented in Article 19 of the ITU Radio Regulations and ITU-R Recommendation M.585-6. MMSI can be used to indetify:

1) Ship (Individual vessel or ship station)
2) Group of vessels
3) Shore station or group of shore stations

4) Search and Rescue Aircraft
5) AIS Aids to Navigation (AtoN)

The structure of MMSI can be seen on the following table:

Table 3:Structure of MMSI Number

| Type of MMSI number | Description Structure of the number |
|---|---|
| Individual vessel (Ship station) | $M_1I_2D_3X_4X_5X_6X_7X_8X_9$ |
| Group of vessels | $0_1M_2I_3D_4X_5X_6X_7X_8X_9$ |
| Shore station or group of shore stations | $0_10_2M_3I_4D_5X_6X_7X_8X_9$ |
| SAR aircrafts | $1_11_21_3M_4I_5D_6X_7X_8X_9$ |
| Navigation aids | $9_19_2M_3I_4D_5X_6X_7X_8X_9$ |

All individual vessels (ship station) MMSIs use the format $M_1 I_2D_3X_4X_5X_6X_7X_8X_9$ where in the first three digits represent the Maritime Identification Digits (MID) and X is any figure from 0 to 9. First 3 digits of MID indicates country code between 200 to 799. For instance, MID code of Indonesia is 525. On this study focused on MMSI for individual vessel (ship station) only.

## 3.0 DEVELOPMENT OF AIS SYSTEM IN BATAM-SINGAPORE WATERWAYS

On this paper, we try to develop an AIS system for record, decode and visualize of AIS message sent by ships passing through Strait of Singapore and Batam Waterways. The system consist of AIS receiver equipments, AIS record and decode software & web based interactive visualization application to visualize the vessels traffic. The system is installed in Politeknik Negeri Batam as AIS receiver station.

### 3.1 Overview of AIS Station

AIS receiver station in Politeknik Negeri Batam is used to record AIS data sent by ships which passing the nearby strait from station. The station consist of several hardware and device such as AIS antena, AIS receiver and personal computer (PC). The connection diagram of AIS station show in figure 4.

Table 4: AIS station devices

| No | Device | Specification |
|---|---|---|
| 1 | AIS receiver | Brand: AMEC CYPHO-150<br>Applicable standards: IEC 62287-1, ITU-R M.1371, IEC 60945 and IEC 61162<br>Number of AIS Receivers: 2 channels<br>CH-1: CH 87B (161.975MHz)<br>CH-2: CH 88B (162.025MHz)<br>Channel Bandwidth: 25KHz<br>Message Format: AIS Class A & B messages<br>Data Rate: 9,600bps / per channel<br>Receive Sensitivity: -112 dBm @ PER ≤ 20% |
| 2 | AIS | VHF antenna |
| | Antena | |
| 3 | Personal computer (PC) | Mini PC<br>Model: Intel NUC NUC5CPYH<br>CPU Speed: 1-2Ghz<br>Processor Type: Dual-core<br>Tipe Processor: Intel |

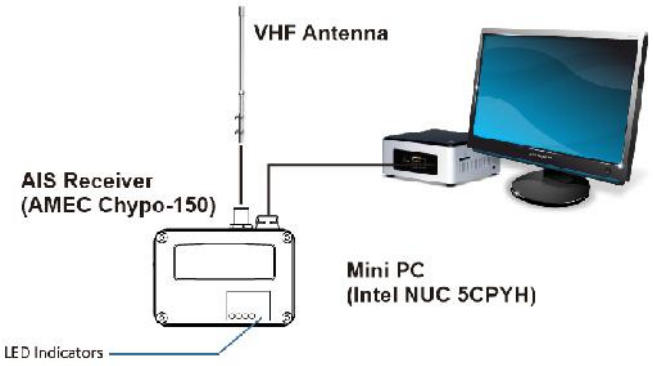



Figure 4: Connection Diagram of AIS Station

Figure 5: AIS station set-up on top building of Politeknik Negeri Batam

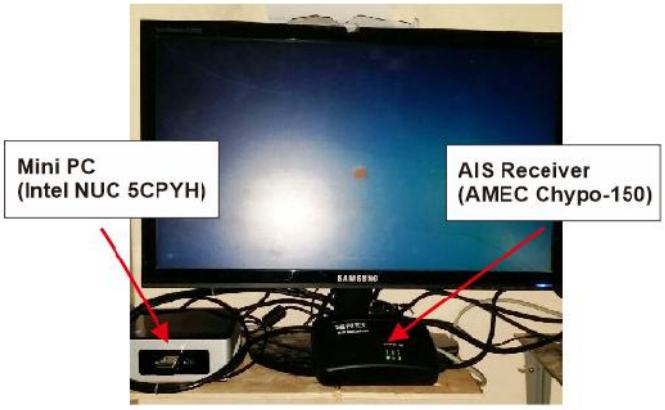



Figure 6: AIS station devides

### 3.2 Development of AIS System in Singapore Strait- Batam Waterways

On this study, the AIS system for record and decode was developed using LabView as showed in figure 7 named NMEA Receiver. The AIS data sent by ships will be received by AIS receiver and simultaneously stored in hardisk on the PC. The AIS data was stored in NMEA 0183 fomat.

The NMEA message from AIS receiver will be simultaneously decoded and stored in in the hardisk on the PC. The NMEA Receiver will be created two different database of record & decode files and stored both databases in the different location of hardisk on the PC. The information obtained from AIS decoded was consist of Tanggal (Date), Jam (time), Packet Type, Channel, AIS Type, Repeat Indicator, MMSI, Navigation Status, Rate of Turn, Speed Over Ground, Position Accuracy, Longitude, Latiitude, Course Over Ground, True Heading, Time Stamp, and Maneuver Indicator. The AIS raw data (NMEA massage) was recorded as shown in figure 2 and decoded as shown in figure 3 in every hour.

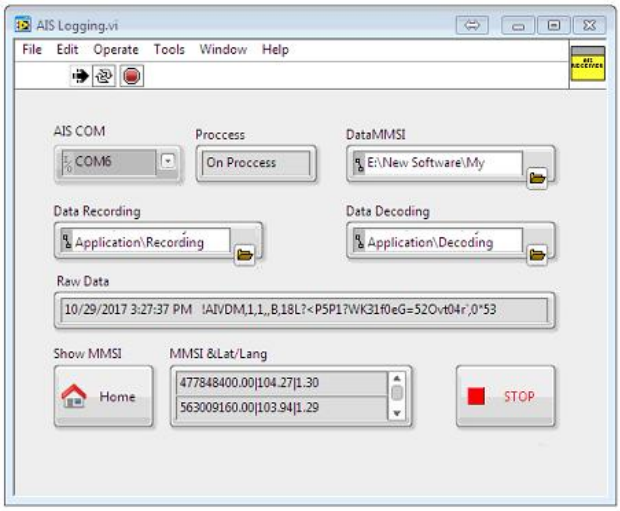



Figure 7: The AIS record and decode

Firstly in this development of AIS system is by running the NMEA Receciver as shown in figure 7. The use of the apllication started from selecting port serial of USB connection from AIS receiver equipment. Then, selecting location for stored data recording, data decoding and data MMSI on hardisk in the PC. Data recording is database of NMEA 0183 message received from AIS receiver that will be stored on the choosen location. Data decoding is a database as result of decode AIS message that will be stored on the choosen location. Recording and decoding database will be saved on txt and csv format for every single hour. Data MMSI is a collected MMSI that filtered by every single hour of decode result.

The decode process can be seen by clikcing the home button on control panel. This feature will show the information as fastly for every single message of AIS such as Message Type, Repeat Indicator, MMSI, Navigation Status, Rate of Turn (ROT), Speed Over Ground (SOG), Position Accuracy, Longitude, Latiitude, Course Over Ground (COG), True Heading, Time Stamp, Maneuver Indicator, Spare, RAIM Flag and Radio as shown in figure 8.

Secondly, the system can be used for navigation tracking or vessels tracking monitoring by visualize the longitude and latitude data which obtained from AIS decoded. This application will show the possition of ships (MMSI) on the map and show some data of the AIS such as Speed Over Ground (SOG), Course Over Ground (COG), Date and MMSI as shown in figure 9. The full detail of ships can be identified in the decode database.

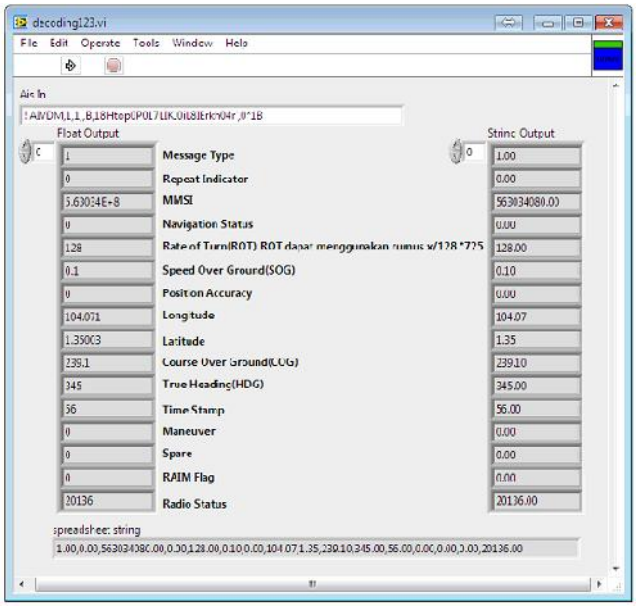
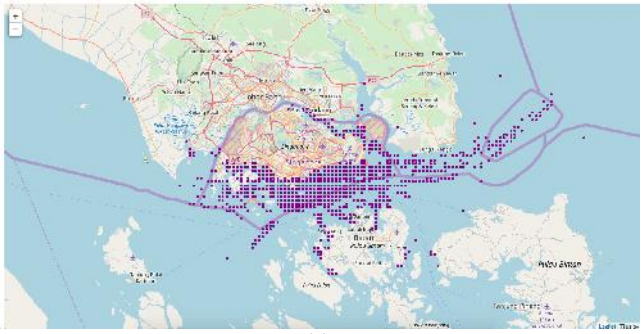
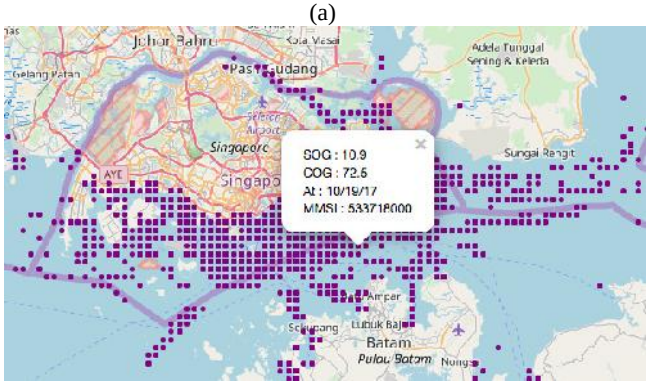



Figure 8: Decode process shown on the application



(a)




(b)

Figure 9: (a) Ship distribution visualize on the web based interactive visualization application (b) Information show on the maps by click the icon

The web based interactive visualization application was created by applying library Leafleat.js to process AIS decode data to output map interactive marine traffic information visualization. Raw data (AIS decoded data) which is formed in CSV (comma separated file) converted to JSON (JavaScript Object Notation) pass through preprocessing to filter data from inconsistency and redundant information. GeoJSON format is extended version of JSON which speciallized for geolocation data. Normally map

visualization only exhibit data synchronously, but in this research we perform dynamic representation of big Data interactively. Moreover, user be able to interact directly with the data. Interaction provided in this application are click, zoom and filter to focus on data subset as shown on figure 9.

Tabel 5: Vessels traffic in the Strait of Singapore and Batam Waterways on 20 Oct 2017 at 00.00 – 23.29

| No | Time | Total MMSI | Individual Vessel (Ship Station) | Others | % Others |
|---|---|---|---|---|---|
| 1 | 00:00 | 1030 | 992 | 38 | 3.69% |
| 2 | 01:00 | 961 | 926 | 35 | 3.64% |
| 3 | 02:00 | 972 | 937 | 35 | 3.60% |
| 4 | 03:00 | 917 | 883 | 34 | 3.71% |
| 5 | 04:00 | 903 | 867 | 36 | 3.99% |
| 6 | 05:00 | 922 | 887 | 35 | 3.80% |
| 7 | 06:00 | 970 | 939 | 31 | 3.20% |
| 8 | 07:00 | 941 | 908 | 33 | 3.51% |
| 9 | 08:00 | 1053 | 1018 | 35 | 3.32% |
| 10 | 09:00 | 1066 | 1029 | 37 | 3.47% |
| 11 | 10:00 | 1084 | 1045 | 39 | 3.60% |
| 12 | 11:00 | 1045 | 1009 | 36 | 3.44% |
| 13 | 12:00 | 1048 | 1011 | 37 | 3.53% |
| 14 | 13:00 | 1077 | 1041 | 36 | 3.34% |
| 15 | 14:00 | 1035 | 1000 | 35 | 3.38% |
| 16 | 15:00 | 980 | 947 | 33 | 3.37% |
| 17 | 16:00 | 958 | 922 | 36 | 3.76% |
| 18 | 17:00 | 996 | 960 | 36 | 3.61% |
| 19 | 18:00 | 1021 | 988 | 33 | 3.23% |
| 20 | 19:00 | 968 | 933 | 35 | 3.62% |
| 21 | 20:00 | 923 | 889 | 34 | 3.68% |
| 22 | 21:00 | 906 | 873 | 33 | 3.64% |
| 23 | 22:00 | 803 | 770 | 33 | 4.11% |
| 24 | 23:00 | 824 | 791 | 33 | 4.00% |
| **Average** | | 975 | 940 | 35 | 3.59% |

Table 5 shows the vessels traffic in the Strait of Singapore and Batam Waterways every hours on 20 October 2017. There are average of 975 ships passing through the staits hourly indicated by MMSI. The average MMSI hourly for individual vessels (ship station) and other MMSI were about 940 MMSI (96.41%) and 35 MMSI (3.59%) , respectively.

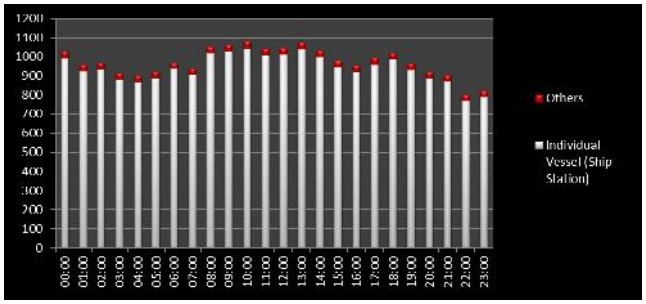



Figure 10: Number of ships (MMSI) hourly passed through the strait between Batam and Singapore on 20 Oct 2017

This study focused on individual vessels (ship station) only that has 9 digits of MMSI structure using format of $M_1I_2D_3X_4X_5X_6X_7X_8X_9$ as shown in table 3**.** The values of first 3 digits of MID that identified as individual vessels (ship station) between 200 to 799. This values also indicates country code of the vessels.

The values excluding on the MID limits of individul vessels (ship station) was identified as others type of MMSI. This can be identified as group of vessels, shore station or group of shore stations, SAR aircrafts and navigation aids.

## 4.0 CONCLUSION

The AIS system has an important function in the port traffic management because the system can give an accurate possition of the target ships. The development of AIS system in this study showed that the system can be used to monitor the vessel traffic in the Stait of Singapore and Batam Waterways as one of the world's most congested straits used for international shipping.

The AIS system developed in this study has many advantages especially in capability for record & decode of AIS message and good visualization of the vessels traffic using web based interactive visualization application. The system has been tested by running the AIS record, decode and web visualisation and shown that the system could be applied to vessel traffic monitoring.

However, several future work need to be done to improve the capability of the system. First, need to develop a real-time visualization system for traffic monitoring. Second, the system need additional ship database such as ship principle dimension, GT, DWT and etc so that the ships data for analysis and visualization is not only MMSI number but real ship data.

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