BACHELOR THESIS & COLLOQUIUM – ME 184841

DEVELOPMENT OF AUGMENTED REALITY ANDROID-BASED APPLICATION FOR FIRE CONTROL PLAN

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DOUBLE DEGREE PROGRAM OF
DEPARTEMENT OF MARINE ENGINEERING
FACULTY OF MARINE TECHNOLOGY
INSTITUT TEKNOLOGI SEPULUH NOPEMBER
SURABAYA
2019

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SKRIPSI – ME 184841

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APPROVAL FORM

DEVELOPMENT OF AUGMENTED REALITY ANDROID-BASED APPLICATION FOR FIRE CONTROL PLAN

BACHELOR THESIS

Submitted to Comply One of the Requirements to Obtain a Bachelor Engineering Degree
on
Laboratory of Marine Operational and Maintenance (MOM)
Bachelor Program Departement of Marine Engineering
Faculty of Marine Technology
Sepuluh Nopember Institute of Technology

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DECLARATION OF HONOR

I hereby who signed below declare that:

This final project has written and developed independently without any plagiarism act. All contents and ideas drawn directly from internal and external sources are indicated such as cited sources, literatures and other professional sources.

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Departement	:	Marine Engineering

If there is plagiarism act in the future, I will fully responsible and receive the penalty given by ITS according to the regulation applied.

Surabaya, July 2019

Rifqi Assidiqi

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DEVELOPMENT OF AUGMENTED REALITY ANDROID-BASED APPLICATION FOR FIRE CONTROL PLAN

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ABSTRACT

Safety is one of the important aspects that must be considered in building a ship from the design stage. Fire control plan as one of the designs provided is useful as the only source of safety information available on the ship. Guidelines in designing fire control plans can be a difficult problem if the designer does not understand what needs to be done because of the lack of interactive information sources. Interactive educational media is an effective computer-based communication system that can create, store, present, and re-access information. Augmented Reality (AR) as one of the rapidly growing technology, can provide a helpful educational media for educational purposes. The purpose of this study is to develop an Android-based application of fire control plan of MV. Meratus Bontang modelling by combining AR and smartphone. The application is built using AR technology which is added to a specified marker that can be detected on a smartphone and then visualized in a 3D model. As a result, this application can visualize the fire control plan 3D models from the 5 decks of the ship along with the fire-fighting equipment location. Augmented Reality technology is expected to be able to support learning as an additional educational media and improve student learning outcomes especially in maritime industry.

Keywords: Augmented Reality, Android Application, Educational Media, Fire Control Plan.

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PENGEMBANGAN APLIKASI *AUGMENTED REALITY* BERBASIS *ANDROID* UNTUK *FIRE CONTROL PLAN*

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ABSTRAK

Keselamatan adalah salah satu aspek penting yang harus dipertimbangkan dalam membangun kapal dari tahap desain. Rencana pengendalian kebakaran sebagai salah satu desain yang disediakan berguna sebagai satu-satunya sumber informasi keselamatan yang tersedia di kapal. Pedoman dalam merancang rencana pengendalian kebakaran dapat menjadi masalah yang sulit jika perancang tidak memahami apa yang perlu dilakukan karena kurangnya sumber informasi interaktif. Media pendidikan interaktif adalah sistem komunikasi berbasis komputer yang efektif yang dapat membuat, menyimpan, menyajikan, dan mengakses kembali informasi. *Augmented Reality* (*AR*) sebagai salah satu teknologi yang berkembang pesat, dapat menyediakan media pendidikan yang bermanfaat untuk tujuan pendidikan. Tujuan dari penelitian ini adalah untuk mengembangkan aplikasi pemodelan rencana pengendalian kebakaran kapal Meratus Bontang berbasis *Android* dengan menggabungkan teknologi *AR* dan ponsel. Aplikasi ini dibangun menggunakan teknologi *AR* yang ditambahkan ke penanda yang ditentukan yang dapat dideteksi pada ponsel dan kemudian divisualisasikan dalam model 3D. Hasilnya, aplikasi ini dapat memvisualisasikan model 3D rencana pengendalian kebakaran dari 5 geladak kapal beserta lokasi peralatan pemadam kebakaran. Teknologi *augmented reality* diharapkan dapat mendukung pembelajaran sebagai media pendidikan tambahan dan meningkatkan hasil belajar mahasiswa terutama di industri maritim.

Kata kunci: Augmented Reality, Aplikasi Android, Media Edukasi, Rencana Pengendalian Kebakaran

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PREFACE

All the gratitude towards Almighty Allah for all the blessings and gifts so that the author can complete bachelor thesis with title of “Development of Augmented Reality Android-Based Application for Fire Control Plan" in order to fulfill the requirements to obtaining the bachelor degree program at Marine Engineering Department, Faculty of Marine Technology, Institut Teknologi Sepuluh Nopember Surabaya.

During the accomplishment of this final project, author want to thank every parties who helped, assisted, and supported the author so that the author is able to complete this very well. All thanks are delivered to:

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8. MOM Laboratory members
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Because this work is also far from a perfect work, author will really apreciated for every advice, suggestion and idea from all parties for this bachelor thesis correction and improvement in the future. By the completion of this bachelor thesis, author hopes this thesis will be helpful and beneficial for other parties who are going to conduct the similar research.

Surabaya, July 2019

Author

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CHAPTER I
INTRODUCTION

1.1 Background

Ship design, as the first stage in building a ship, must fulfill the request of the owner in terms of it use, such as the demand for capacity, speed, efficiency, etc. Another aspect that must not be ruled out from designing a ship is the safety system. Safety on a ship includes safety equipment, firefighting equipment, safety routes and other safety aspects. This information usually found in a fire control plan.

Fire control plan is a general arrangement of a ship with additional information on safety equipment. Fire control plan shows a variety fire alarm system, sprinkler installation, extinguishing equipment, means of escape to different compartments and decks, and ventilation system including particulars of remote operation of dampers and fans.

In the study of shipbuilding, students must understand ship design very well. To understand ship design in detail, visual understanding is needed through direct observation into the ship. This requires many aspects, from permission to carry out observations on ships, transportation to ships, time availability, and other aspects. To help provide efficient and interactive educational media, technology and information can be used.

As a person who does not know well how to properly design a ship, certainly understanding through learning is needed on how a ship is formed. but this is not enough for someone to be able to understand in detail because the ship is an object that has its own form that must be understood visually.

Development of information and technology accelerates modernization in all fields. The use of information and technology can provide great benefits if it can be used wisely, one of them is by utilizing technology in the field of education. Learning process is essentially a communication process that is, the process of delivering messages from message sources through certain channels or media to the recipient of the message. The use of technology in education one of which is used as a media of learning.

Educational media is a teaching infrastructure that supports activities in lectures. In the learning process the presence of media has a significant role, because in these activities the obscurity of the material delivered can be helped by presenting media as an intermediary. Educational media as a source of learning which can deliver a message so that it can help in the learning problems. Besides being used to deliver learning as a whole, the media can also be used to present certain parts of learning activities, providing reinforcement and motivation. The lack of learning resources can lead to decreased interest in learning, which results in low levels of knowledge. From the above understanding, it can be concluded that educational media is a tool or means of communication used for the learning process. Combinations of the various elements of delivering information and messages, can be designed and used as an effective media technology to learn and teach relevant learning material.

Smartphone can be used as a learning resource for students by providing a multimedia interactive learning. Definition of multimedia, as the integration of more than one media in communicating or combining various media in computer systems. Interactive learning media is an effective computer-based communication system that is able to create, store, present, and re-access information in the form of text, graphics, sound, video or animation (Soenarto, 2009). Learning with visual media devices provides benefits, such as exploring the emotional honesty of individuals, creating effective communication and providing flexibility in learning activities (Turkoguz, 2012). The use of mobile technology as an educational media expanding opportunity for students to improve their learning.

The world of mobile technology is in a constant and growing popularity, becoming more ubiquitous everyday (Ballagas, et al 2006). Mobile devices have increasingly demonstrated their usefulness and applicability in a daily basis, to assist users in their work, to be used in a familiar environment or to support forms of entertainment. The world of smartphones and tablets opens new interaction opportunities and with the evolution of the technology there are emerging devices with high computational capabilities. As a result, the interest in implementing Augmented Reality (AR) applications on mobile systems has increased significantly.

Augmented Reality is a field in which virtual objects are integrated into a real environment in real time. AR supplements the real world with virtual, computer-generated, objects that appear to coexist in the same space as the real world (Krevelen, 2007). In other words, AR is a way to enhance the real world and it may be achieved by adding a layer of virtual-objects on top of the real world. The biggest advantage of augmented reality is the minimal or zero purchase expense because it uses conventional hardware used in many cases. (Petr, 2014).

It was in the beginning of this millennium that researchers started to really see the potential of using AR in education and foresaw further research within the field (Shelton, 2002). Since then, many variations and approaches have been taken in the design of AR used for pedagogical purposes and there's a need for an overview of what has been studied within the field (Wu, Lee, Chang, Liang, 2012).

These systems, which integrate reality with virtual elements, provide the user with an easy and safe interaction, without prior knowledge of this technology. That happens because the movements produced are natural, easy to learn and could be as simple as moving a body part or an object. Augmented reality can be useful in any application that needs to display information not available or not directly detectable by the human senses. Therefore, by becoming visible, it is possible to increase the sense of realism and immersion of this technology (Diogo, Rui, Nino, 2015).

By using augmented reality and smartphone technology, the designated object can be visualized through a 3D virtual modeling that similar with the real object right above the fire control plan with the help of a camera feature on the smartphone. Therefore, the applications that are made as Android-based educational media by utilizing augmented reality technology can be used to help students understand various fire-fighting equipment and its placement on the ship properly.

Based on the problem statement above, then an application will be developed to support the learning process of Fire Control Plan modeling by combining augmented reality and Android-based smartphone to be able to support learning as an additional media and improve student learning outcomes. The advantage of augmented reality is that it can explain in detail and completely for a design modeling compared to conventional educational media and also this only requires a simple marker object to support the application. Hence, the educational media that will be developed requires good quality standards. It is expected that the application that will be made can facilitate and also attract the interest of users in learning the modeling of Fire Control Plan which can be accessed at any time.

1.2 Research Problems

1. How to visualize the form of Fire Control Plan of MV. Meratus Bontang on augmented reality model?
2. How to provide fire-fighting equipment information based on its location on board?
3. How to develop augmented reality application as a media in learning?

1.3 Objectives

1. To visualize the form of Fire Control Plan on augmented reality model
2. To provide fire-fighting equipment information based on its location on board
3. To develop augmented reality application as a media in learning

1.4 Research Limitations

1. The application is made for Android-based mobile devices
2. Using the marker method in the object input process
3. Only provide fire-fighting equipment location based on its Fire Control Plan
4. Only visualize the Fire Control Plan of MV. Meratus Bontang

1.5 Benefits

1. Provide visualization the form of Fire Control Plan on augmented reality
2. Provide fire-fighting equipment information based on its location on board
3. Provide augmented reality application as a media in learning.

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CHAPTER II
LITERATURE STUDY

2.1 Fire Control Plan

2.1.1 General Definition of Fire Control Plan

Fire control plan show a variety fire alarm system, sprinkler installation, extinguishing equipment, means of escape to different compartments and decks, and ventilation system including particulars of remote operation of dampers and fans. The position of various dampers, its marking, and which fan is for particular compartment or deck is also explained so that required damper and fans can be closed in case of fire. Consideration of the ship safety system is required when the ship is designed to prevent fire on the ship itself. Fire accidents can cause material losses and fatalities. The rules regarding of fire protection, fire detection, and fire extinction are based on International Convention for the Safety of Life at Sea (SOLAS) Chapter II-2 (IMO, 2004).

The structural fire protection arrangements shown on the fire control plan should clearly indicate details of all stairways, machinery spaces, lift, vertical light and air shafts, the divisions (bulkheads and decks) separating accommodation spaces from other spaces such as fish holds and main store spaces. Standards of insulation for decks and bulkheads, fire resisting doors, shutters and ventilation dampers should be shown and the plan is to be drawn to a sufficiently large scale to permit a full and clear presentation of the information. As the opportunity occurs the surveyor should impress on owners and the vessel's officers the importance of the presence on board of up to date and comprehensive information so that the personnel responsible for fire-fighting are fully aware of the structural protection arrangements on their particular vessel (UK MCA, 2014).

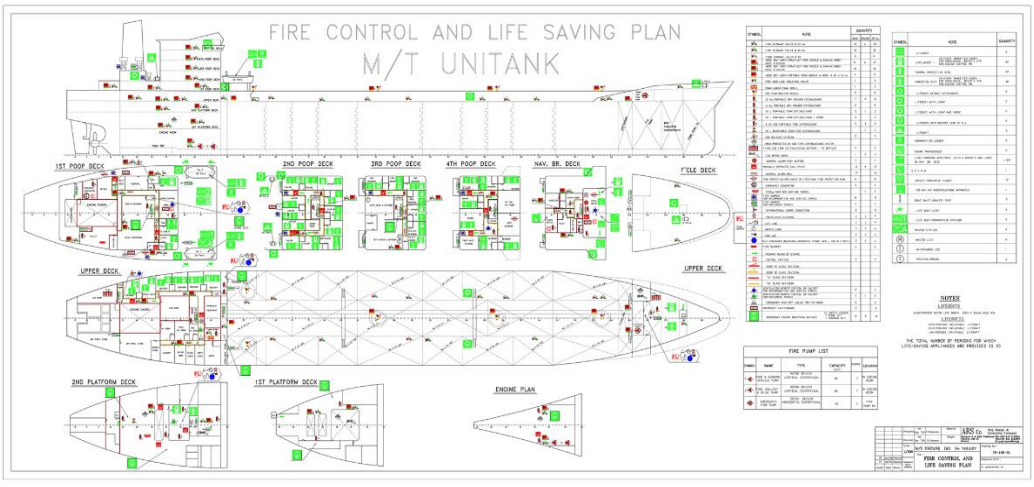

Figure 2. 1 Fire Control Plan
Source: (ARS co. Ship Design & Consulting Company, 2019)

2.1.2 Fire Safety Objectives

The regulations explain the details of fire safety provisions for all ships and specific measures for passenger ships, cargo ships and tankers. They include the following principles (SOLAS, 2004):

a) Prevent the occurrence of fire and explosion
b) Reduce the risk to life caused by fire
c) Reduce the risk of damage caused by fire to the ship, its cargo and the environment
d) Contain, control and suppress fire and explosion in the compartment of origin
e) Provide adequate and readily accessible means of escape for passengers and crew.

2.1.3 Fire Safety Functional Requirements

In order to achieve the fire safety objectives, the following functional requirements are embodied in the regulations of as appropriate (SOLAS, 2004):

a) Division of the ship into main vertical and horizontal zones by thermal and structural boundaries
b) Separation of accommodation spaces from the remainder of the ship by thermal and structural boundaries
c) Restricted use of combustible materials
d) Detection of any fire in the zone of origin
e) Containment and extinction of any fire in the space of origin
f) Protection of means of escape and access for fire fighting
g) Ready availability of fire-extinguishing appliances
h) Minimization of possibility of ignition of flammable cargo vapour.

2.2 Augmented Reality

2.2.1 Definition of Augmented Reality

Augmented reality is a term for an environment that combines real world and virtual worlds made by computers so that the boundary between the two becomes very thin. Virtual objects are added instead of replacing real objects. Whereas, the purpose of augmented reality is to simplify the real object by bringing virtual objects into it, so that it can deliver information to users who interact with the user interface of the real object. (Afissunani, 2014).

Augmented reality is an interaction technology that can combine 2-dimensional or 3-dimensional virtual objects that will be added into the real environment and combine them so as to create mixed reality and project it into real time, so that augmented reality is a technology that combines interaction between the real world and virtual world.

Augmented reality is defined as a system that combines elements from the real world with virtual elements (3D) and that allows interactivity between objects (real

and virtual) in real time (Azuma, 1997). Those virtual elements allow user to display certain information, which a given user cannot detect directly only through their own senses. Thus, augmented reality changes the way human see the world, which increases the perception and interaction of a user with reality.

Based on the above definition, AR can be simply defined as a real environment that is added by virtual objects with the integration of computer technology. This technology can present an attractive interaction for the user, because with this technology the user can feel the virtual objects as if they really exist in the real world.

2.2.2 Method of Augmented Reality

There are two types of imaging methods in augmented reality (Lyu, 2012) namely;

1) Marker-based Tracking

   One method that has long been recognized in augmented reality technology is the Marker-based Tracking. This method requires markers in the form of images that can be analyzed to form reality. The distinctive picture that can be recognized by the device is called the marker. A marker can be anything, as long as it has enough unique visual points. Images with lots of corners and edges work especially well. Typical examples include any print media, such as logos, packaging, posters or brochures. Or objects, often a product itself such as a drinks can, bottle, or even machinery.

   Marker-based AR has a characteristic that is using the camera feature on the device for analyzing the captured marker to display virtual objects such as video and image. Users can move the device to see virtual objects at various different angles. So that users can see virtual objects from all sides.

Figure 2. 2 Marker-based Tracking Display Principle
Source: (V&B Augmented Reality App, 2019)

2) Markerless AR

Another method of augmented reality that is currently developing is the Markerless AR method. With this method the user no longer needs to use a marker to display objects or digital elements. This approach eliminated the need for 3D object tracking systems, overcoming the interactivity limitations marker-based augmented reality placed on the range of images encapsulated within the markers. A markerless application recognizes objects that were not directly provided to the application beforehand. This scenario is much more difficult to implement because the recognition algorithm running in the AR application has to identify patterns, colors or some other features that may exist in camera frames. For example, if the algorithm is able to identify dogs, it means that the AR application will be able to trigger AR actions whenever a dog is detected in a camera frame, without user having to provide images with all the dogs in the real environment when developing the application.

Examples of markerless AR are Face Tracking, 3D Object Tracking, and Motion Tracking. In addition, there are also AR that uses GPS or digital compass features. GPS Based Tracking technique utilizes the GPS and compass features in the smartphone, the application will display it in the form of a direction or place that the user wants in real time.

Figure 2. 3 Markerless Tracking Application User Interface
Source: (Niantic, 2019)

2.3 Augmented Reality Component

In its application, augmented reality technology has several components that must be present to support the performance of digital image processing. The components are as follows (Sylva, et al. 2003):

a) Scene Generator
   Scene Generator is a device or software that functions to do rendering. Rendering is the process of building images or certain objects in AR.
b) Display
   There are several factors that need to be considered in the development of the AR system, such as the factor of resolution, flexibility, point of view, and tracking area. On the tracking area, the lighting factor becomes a matter that needs to be considered because it can affect the display process.

c) Tracking
   Tracking system is the most important component in augmented reality. In the tracking process, a detection of virtual objects is carried out with real objects with certain patterns.
d) AR Device
   AR can be used on several operating systems on smartphones. At present, several applications with AR technology are available on Android, iPhone, Windows Phone, and others. In addition, AR can also be used on PCs and televisions connected with cameras such as webcams.

2.4 Unity

Unity is a software that can be used to build games with various technologies which include graphics, audio, physics, interactions, and networking (Unity, 2019). Unity 3D is a game engine based on multi-platform, so unity is used to create games that can be used on personal computer, Android and iPhone smartphones, PlayStation and Xbox consoles. The mission of Unity is "democratize game development", which means that Unity will make the development tools are easy to use, has a good quality 3D games, and capable of running on multiple platforms. The main functions provided by Unity game engines include an engine renderer that is useful for rendering 2D or 3D graphics, a physics engine to make 3D objects act like real objects, sound, scripts, animation, artificial intelligence (AI), network, streaming, and animated graphics.

In addition, Unity is not only used to build games but also can be used as an interactive 3D or 2D software development tool such as training simulations for industrial purposes, architectural visualization, mobile-based applications, laptops, web, consoles and various other platforms. Developing a virtual 3D by using a game engine is a strategy to combine various multimedia data into one platform. Characteristics of game engines that are installed interactively, allowing users to explore and engage with game objects (Indraprastha, 2009).

Figure 2. 4 Unity Software User Interface
Source: (Unity, 2019)

Unity has a complete framework for the development of various professional technologies. This engine system uses several choices of programming languages, including C #, JavaScript and Boo. To support diverse functions of the software, Unity has various features that can be used, including the following:

a) Scripting
   Programmers can use UnityScript, C #, or Boo as the programming language. Starting with the release of version 3.0, Unity includes a version of MonoDevelop which is used for script debugging.
b) Animation
   With the animation display feature on Unity, it allows developers to create and edit animated clips directly in Unity. This feature is made so that Unity can create additional functions to create 3D animations.
c) Platform
   Unity supports software development on various platforms. In a project, the developer has control to create software to mobile devices, web browsers, desktops or consoles. Unity also allows texture compression specifications and resolution settings on each supported platform. The supported platforms are Windows, Mac, Linux, Android, iOS, Windows Phone, Unity Web Player, Adobe Flash, PlayStation 3, Xbox 360, Wii U and Wii. In this development, the application will only run on the Android platform.
d) Asset Store
   Unity Asset Store is a resource available to Unity editors. Asset store consists of a collection of massive asset packages, along with 3D models, textures and materials, sound effects, tutorials and projects, package scripting, editor extensions and networking.

2.5 Vuforia

Vuforia is an augmented reality Software Development Kit (SDK) that can be called a plugin to create augmented reality application that can be used on mobile devices. Vuforia software is used as additional compulsory software (plugins) in the Unity software so that the software can produce augmented reality applications used on mobile devices and the plugin software is free (open source) to download. Vuforia SDK has the ability to detect and recognize an object with its computer vision technology. The object recognition feature is as follows:

a) Image Targets
   Image Targets are flat images, such as print media or on the packaging of a product. Image Targets represent images that Vuforia Engine can detect and track.
b) Multi-Targets
   A Multi-Target is an object created with more than one image target in a defined geometric arrangement.

c) Cylinder Targets
   Cylinder Targets are images that line cylindrical shaped objects such as bottles, cups, sodas, etc.
d) Text Recognition
   Text Recognition allows developers to build applications that can detect words on Vuforia word list, which are more than 100,000 words in English.
e) Object Recognition
   Object Recognition allows developers to create applications that can detect irregular objects.
f) Smart Terrain
   Smart Terrain allows developers to build game or visualization applications that can present visual interactions that their content can interact with physical objects in the real environment.

2.6 Previous Research

There are several related studies that will be used as reference material and comparison of research results. The studies are as follows:

1) Research conducted by Briyan Anugerah Pekerti (2017) with the title *"Pengembangan Aplikasi Augmented Reality Untuk Meningkatkan Hasil Belajar Siswa SMP Negeri 2 Banyumas Pada Mata Pelajaran IPA Tata Surya"*. This research aims to develop the application of augmented reality on science subjects the solar system study material to improve the quality of learning from the aspects of achieving learning outcomes. The results of the study show that the developed media are feasible and meet the requirements to be used as educational media for science subjects the solar system study

material in 3rd grade of Junior High School. This can be seen from the percentage of the average score of the media expert validation that is 92% seen from 3 aspects, namely the aspect of efficiency, and of appearance, and aspects of technical quality as well as the percentage of the average score of the material expert that is 90% seen from the aspects of learning and aspects of material accuracy.

Limitations encountered are only Android 2.3 versions of Gingerbread and newer that can run this application, and researchers recommend that smartphones be connected to the internet so that users get the maximum application experience.

2) Research conducted by Miftah Rizqi Hanafi (2015) with the title *"Analisis Dan Perancangan Aplikasi Geometra, Media Pembelajaran Geometri Mata Pelajaran Matematika Berbasis Android Menggunakan Teknologi Augmented Reality"*. Application research and development uses Research and Development (R&D) method that aim to produce certain products and test the effectiveness of the products. The product is developed using the waterfall process model method. The waterfall software development model has five stages, namely communication, planning, modeling, construction, and deployment.

   The purpose of this study is to develop application that can help junior high school students in understanding geometric objects that build space on mathematics subjects and determine the level of feasibility of applications developed in terms of functional aspects, performance efficiency, portability, and usability. The results of these tests are the application stated very well from the functional aspects of suitability and portability. While the performance efficiency and usability aspects of the application are stated to be good.

CHAPTER III
METHODOLOGY

3.1 Methodology Flowchart

The methodology flowchart shows every step of doing this final project which is shown in figure below:

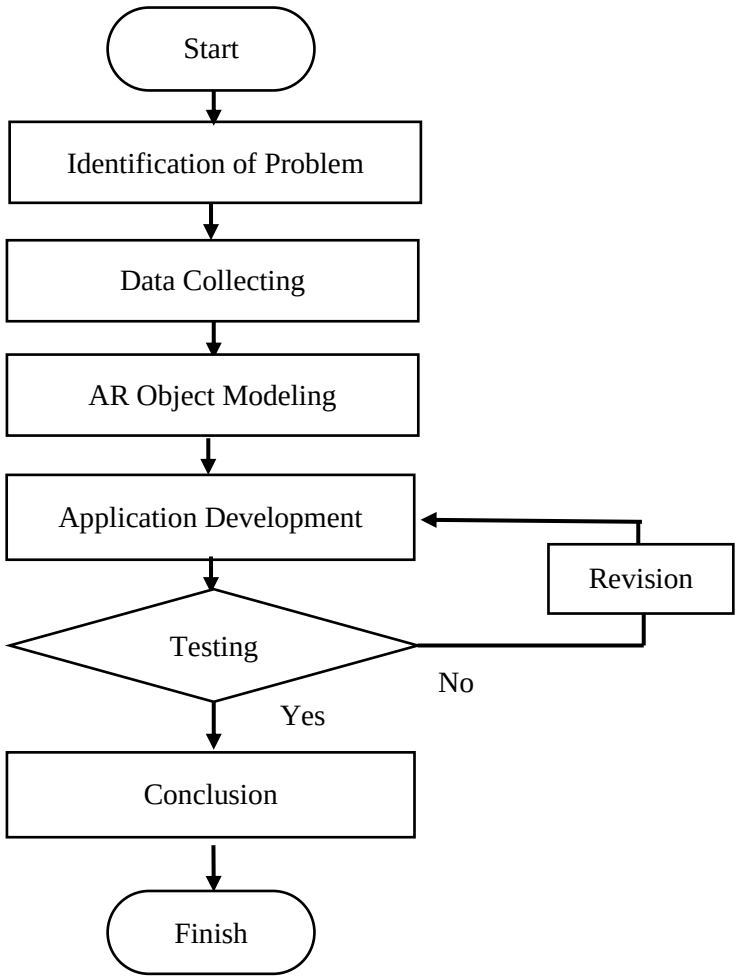

Figure 3. 1 Methodology

3.2 Description of Methodology Flowchart

- Identification of problem
  Identification of problem is the first step to determine the concern of the research by identifying why the research is done and what the benefits of the research are. In this case, the problem is started because the needs of advanced educational media to understand the fire control plan. With the growth of information and technology, then the research will offer solution to overcome the problems by developing an augmented reality application for the educational media.
- Literature Study
  Literature study is a step to summarize the basic theories, guidelines, particular issues and others information in relation to the research by reading any books, journals, previous thesis and other supporting information from internet.
- Data Collecting
  Data collecting is a step to gather the data needs for the application development such as the fire control plan, fire-fighting equipment list, and the equipment location on board. It is done by doing a visual survey to the one of Meratus Line's ship which is MV. Meratus Bontang in Tanjung Perak Port. From this activity, it will obtain the required data. By comparing the fire control plan with the actual condition on ship, the visualization of every decks on ship and its fire-fighting equipment will become clear and can avoid mistakes in 3D modelling. This survey is also helpful to determine and locate the fire-fighting equipment precisely. The total of decks that will be made into 3D model are 5, consist of "B" Deck, "A" Deck, Upper Forecastle Deck, Lower Forecastle Deck, and Main Deck
- AR Object Modeling
  The object modelling is a step to design of fire control plan 3D model that consists of ship model, fire-fighting equipment, etc. It is done by analyzing the data obtained from the survey that have been conducted. By comparing and sorting the data, then will be obtained the final 3D model of ship's decks, and fire-fighting equipment along with the location and its information. The 3D model will be drawn in Blender which is a free and open source 3D computer graphics software used for creating 3D models, visual effects, 3D interactive application, etc. The model will be finalized into as close as the actual object. After the final 3D rendered, the model will be added to the Unity which is also a free and open source cross-platform game engine software. The independent object that has been made in Blender such as the ship decks and fire-fighting equipment will be put together.Application Development
  Application Development is the step after the modeling is complete which will later be included in Android application.
- Application Development

The supporting tools used in developing the application are Vuforia SDK as the additional script to be used as the augmented reality plugin. This plugin is used to make the 3D model can be transforming into an interactive augmented reality model. Android SDK, it includes sample projects with source code, development tools, an emulator, and required libraries to build Android applications. The last tool is the main software that provides comprehensive facilities for software development. There are many options can be used as the main software, such as Android Studio, Microsoft Visual Studio, Eclipse, etc. In this research, Android Studio have become the main software development of the application. These tools can simplify the work of augmented reality Android application development because all of the components already integrate one another.

- Testing
  Testing is a step to run a trial for the functionality check of the application to make it sure that the application can
  perform its functionality flawlessly. It is done when the early version of application has been made to check any possibilities of bugs or errors. And perform final check when the final version of the application has been made to ensure the application run smoothly without any errors when it will be released later.
- Conclusion
  The final step is providing the conclusion and report after completing the development of augmented reality Android application-based with its modeling and design as an educational media.

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CHAPTER IV
RESULTS AND DISCUSSION

4.1 Data Overview

The data and material to build the fire control plan augmented reality application consist of two main data which are fire control plan of MV. Meratus Bontang and visual data of ship such as photos and videos on the actual condition based on survey that has been conducted. The data will be used to make the 3D model and application development.

Hardware and Software Requirements

1) Hardware
   - Windows Computer
   - Android device
2) Software
   - Unity 5.6.2
   - Blender 2.79
   - Vuforia SDK
   - Android SDK
   - Android Studio

4.1.1. Data of Ship

The data used for fire control plan model is obtained from one of Meratus Line's vessel which is MV. Meratus Bontang. The type of vessel is container ship which has specification data as given in table 4.1:

Table 4. 1 MV. Meratus Bontang Data

Name of Ship	MERATUS BONTANG
Type of Ship	Container
IMO No.	9569865
Year Built	2010
Length Overall	106.68m
Breadth	20.6m
Draught	4.215m

Figure 4. 1 MV. Meratus Bontang

4.1.2. Fire Control Plan

Fire control plan consist of the general arrangement of the ship, fire-fighting equipment on board, etc. Those objects will be drawn into a 3D model so that later can be targeted as an object in the augmented reality application. Fire control plan that has been obtained will then be used as a guidance in making the 3D model of the ship.

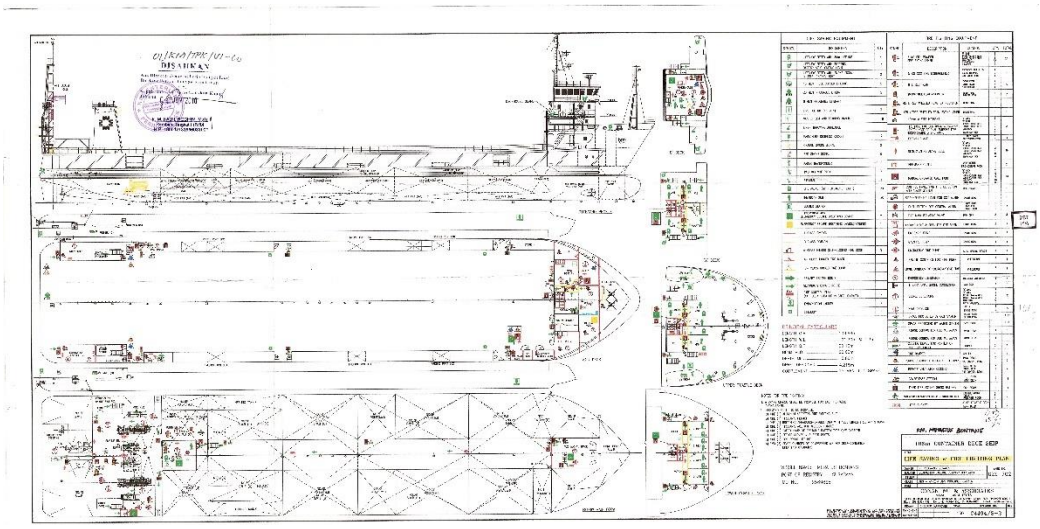


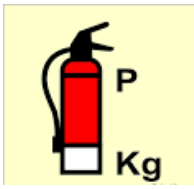
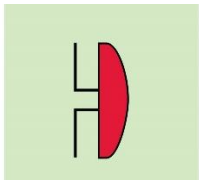
Figure 4. 2 Fire Control Plan of MV. Meratus Bontang

The decks that will be drawn into a 3D model are ‘B’ Deck, ‘A’ Deck, Upper Forecastle Deck, Lower Forecastle Deck, and Main Deck.

4.1.3. Fire Fighting Equipment List

In a ship, there are several types of fire-fighting equipment to prevent and resist from any fire accident. These objects will be visualized in form of 3D model in augmented reality application in every deck where it is located. Table 4.2 shows the fire-fighting equipment lists installed on board.

Table 4. 2 Fire Fighting Equipment List

SYMBOL	DESCRIPTION	LOCATION	QUANTITY
	5 KG DRY POWDER FIRE EXTINGUISHER	"B" DECK "A" DECK UPPER F'CASTLE DECK LOWER F'CASTLE DECK MAIN DECK	2 2 2 4 13
	40 mm ø FIRE HYDRANT	"B" DECK "A" DECK UPPER F'CASTLE DECK LOWER F'CASTLE DECK MAIN DECK	2 2 2 2 1
	FIRE HOSE BOX CONTAINING 40 mm x 15 m.		
	GENERAL/FIRE ALARM BELL	"B" DECK "A" DECK UPPER F'CASTLE DECK LOWER F'CASTLE DECK MAIN DECK	1 1 2 1 5
	MANUAL OPERATED CALL POINT	"B" DECK "A" DECK UPPER F'CASTLE DECK LOWER F'CASTLE DECK MAIN DECK	2 3 3 3 10

	CONTROL PANEL FOR FIRE DETECTION AND ALARM SYSTEM	WHEELHOUSE	1
	PUSH BUTTON FOR GENERAL ALARM	WHEELHOUSE MAIN DECK F'CASTLE DECK	1 1 1
	REMOTE CONTROLS FOR FIRE PUMP	WHEELHOUSE	1
	REMOTE CONTROLS FOR EMERGENCY FIRE PUMPS		
	SMOKE DETECTOR	"B" DECK "A" DECK UPPER F'CASTLE DECK LOWER F'CASTLE DECK MAIN DECK	2 2 2 2 9
	HEAT DETECTOR	GALLEY	1
	FIRE CONTROL PLAN	"B" DECK "A" DECK UPPER F'CASTLE DECK LOWER F'CASTLE DECK MAIN DECK	1 1 1 3 1
	FIRE DAMPER	GALLEY	1

4.2 3D Object Modelling

The 3D models are drawn in Blender which is a free and open source 3D computer graphics software used for creating 3D models, visual effects, 3D interactive application, etc. The model is finalized to be as close as the actual object. After the final 3D rendered, the model then added to the Unity which is also a free and open source cross-platform game engine software. The independent objects that has been made in Blender such as the ship decks and fire-fighting equipment are put together.

4.2.1. Fire-Fighting Equipment 3D Model

There are 13 types of fire-fighting equipment to be drawn into 3D model, below are some of the model drawn in Blender software. Figure 4.3 to figure 4.6 shows the fire-fighting equipment.

4.2.1.1 5 KG Dry Powder Fire Extinguisher

Figure 4. 3 Dry Powder; Actual Condition (left) & 3D Model (right)

4.2.1.2 Heat Detector

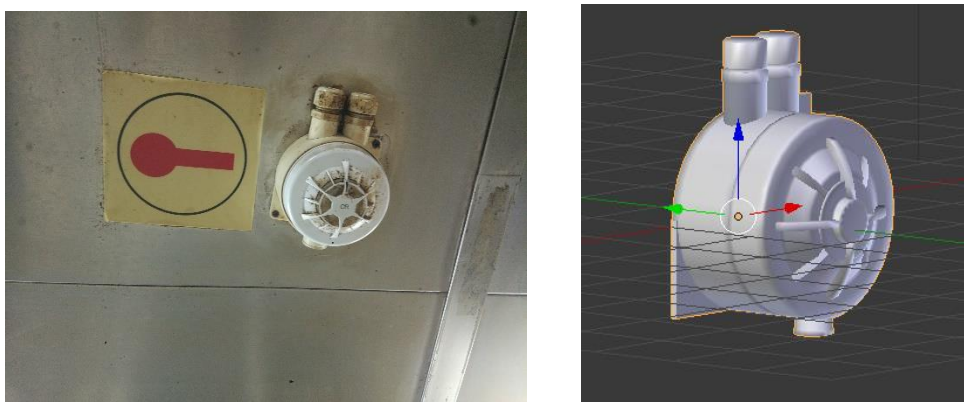


Figure 4. 4 Heat Detector; Actual Condition (left) & 3D Model (right)

4.2.1.3 General/Fire Alarm Bell

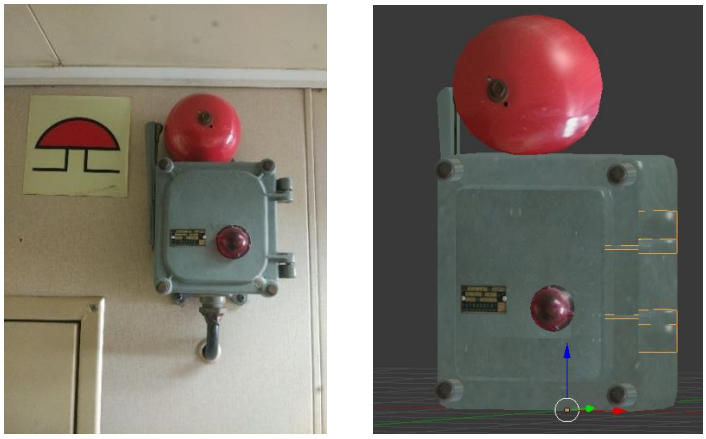


Figure 4. 5 General/Fire Alarm Bell; Actual Condition (left) & 3D Model (right)

4.2.1.4 Fire Hose

Figure 4. 6 Fire Hose; Actual Condition (left) & 3D Model (right)

4.2.2. Ship Deck 3D Model

There are five decks to be drawn into a 3D model. Figure 4.7 to figure 4.11 shows the 5 decks of ship in 3D model.

4.2.2.1. “B” Deck

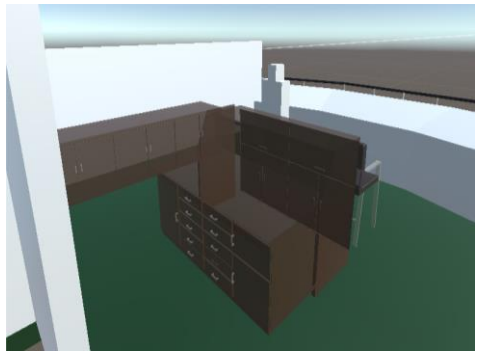
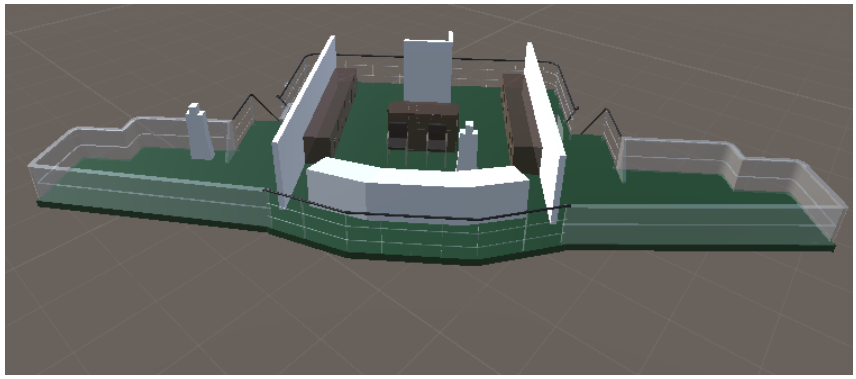
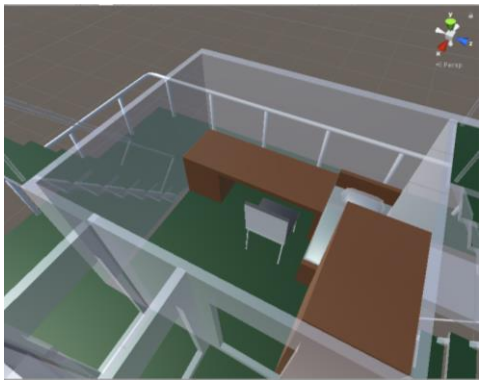




Figure 4. 7 “B” Deck

4.2.2.2. “A” Deck



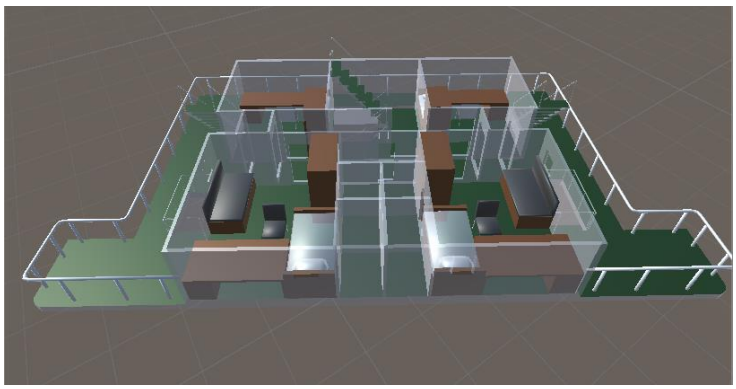


Figure 4. 8 “A” Deck

4.2.2.3. Upper Forecastle Deck

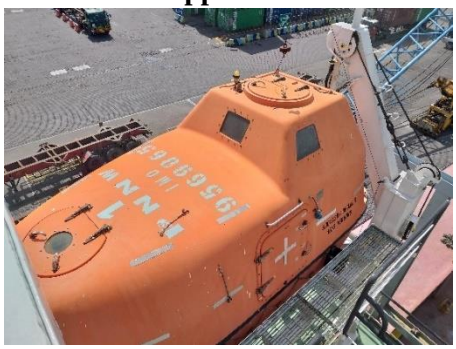
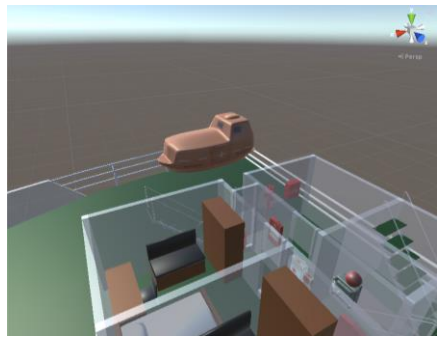
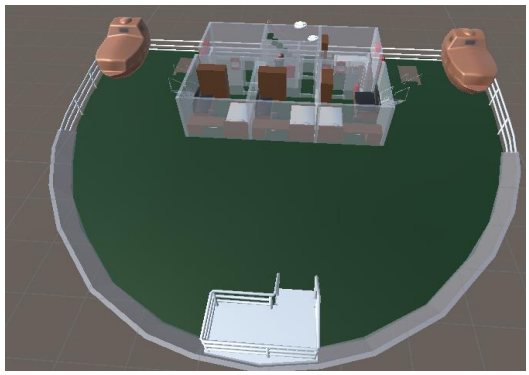
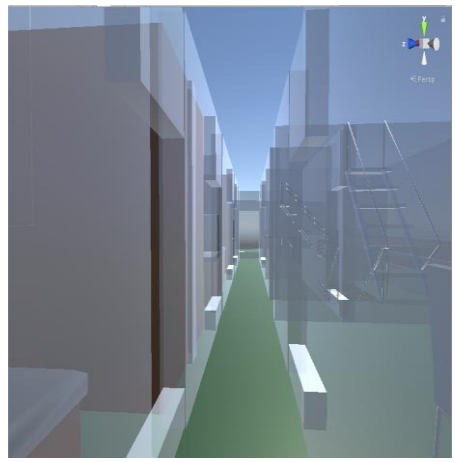




Figure 4. 9 Upper Forecastle Deck

4.2.2.4. Lower Forecastle Deck

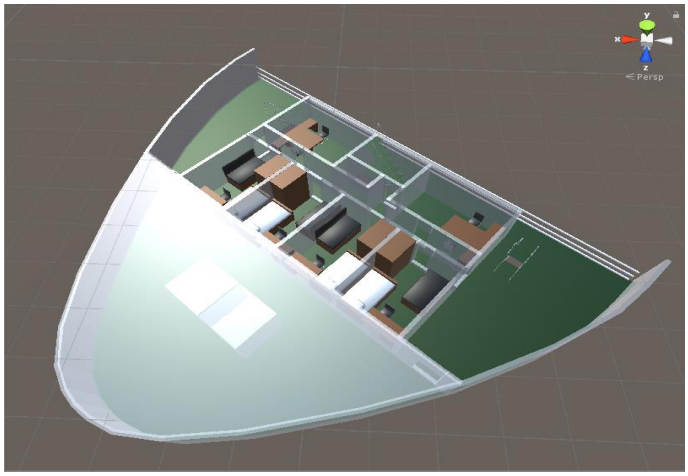
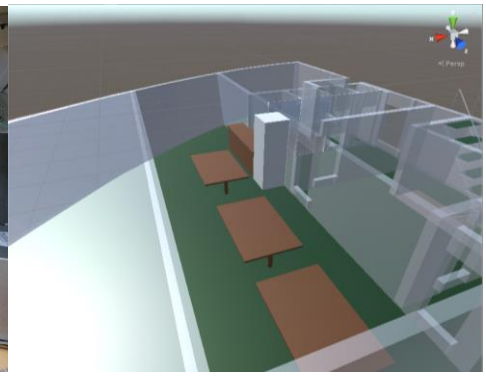


Figure 4. 10 Lower Forecastle Deck

4.2.2.5. Main Deck



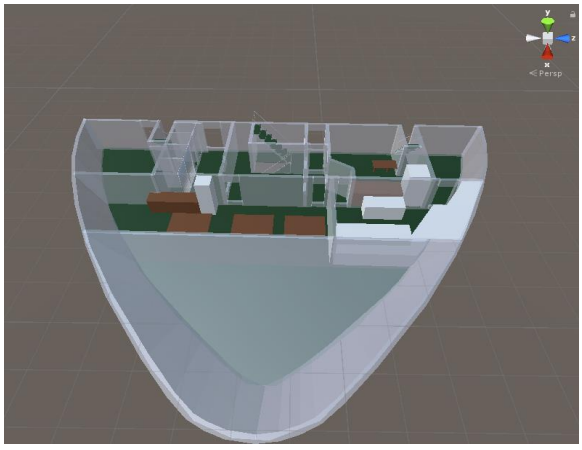


Figure 4. 11 Main Deck

4.2.3. Augemented Reality Android Development

The supporting tools used in developing the application are Vuforia SDK as the additional script to be used as the augmented reality plugin. This plugin is used to make the 3D model can be transforming into an interactive augmented reality model. Android SDK, it includes sample projects with source code, development tools, an emulator, and required libraries to build Android applications. The last tool is the main software that provides comprehensive facilities for software development. There are many options can be used as the main software, such as Android Studio, Microsoft Visual Studio, Eclipse, etc. In this research, Android Studio have become the main software development of the application. These tools can simplify the work of augmented reality Android application development because all of the components already integrate one another.

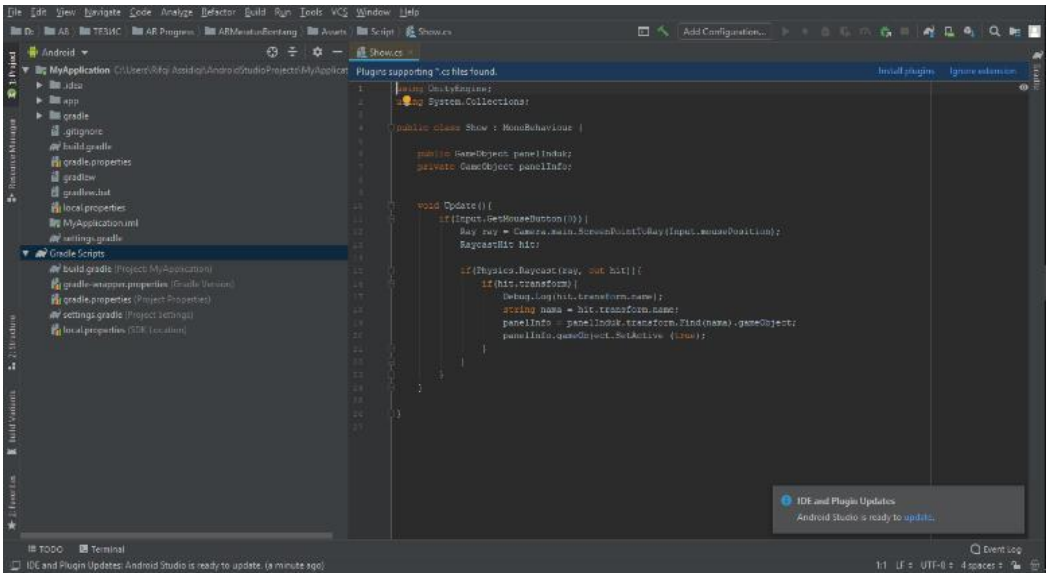


Figure 4. 12 Android Studio User Interface

4.2.3.1. Marker Design

Marker is a unique identifier to be used as an image target of the application. It will visualize the 3D objects in Augmented Reality mode when the camera on smartphone detect the correct information on the marker. Marker to be used in this application obtained from the fire control plan containing five decks of ship. Markers that have been designed are then uploaded to the Vuforia database. This is necessary to be done so that the marker will be listed as a valid target image.

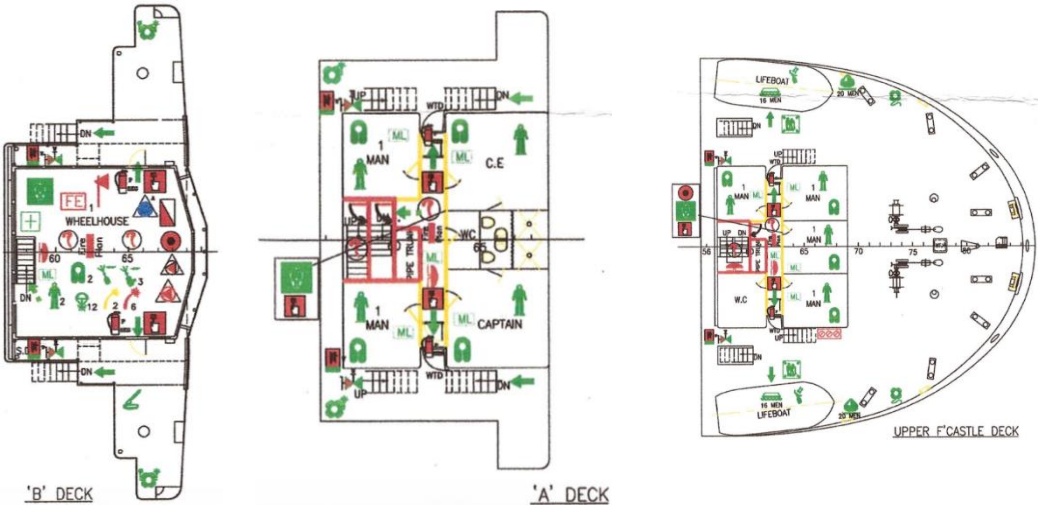


Figure 4. 13 "B" Deck, "A" Deck, and Upper Forecastle Deck Marker

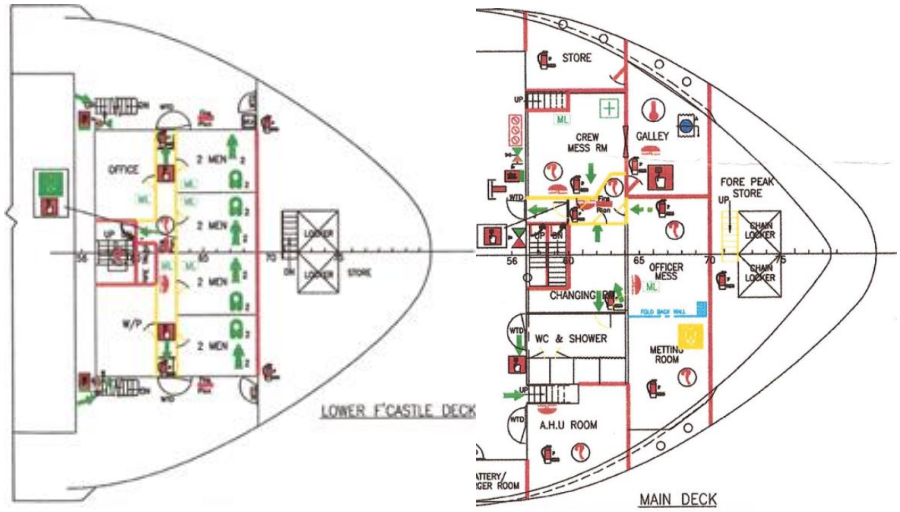


Figure 4. 14 Upper Forecastle Deck, Main Deck

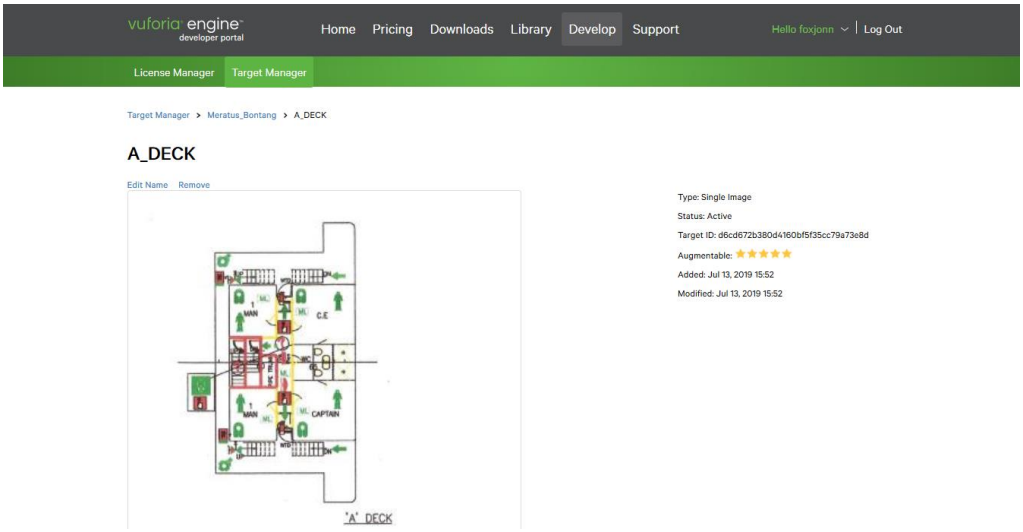


Figure 4. 15 Vuforia Database

4.2.3.2. 3D Model Rendering

Objects that have been drawn in Blender software are the combined according to its position in Unity software. After the models combined, the supporting components added in the Unity editor, such as scripts as the command for the features of the application, Vuforia license key which is obtained after uploading the markers to the server, AR compatibility plugin to display the 3D object in an augmented reality mode, and other components.

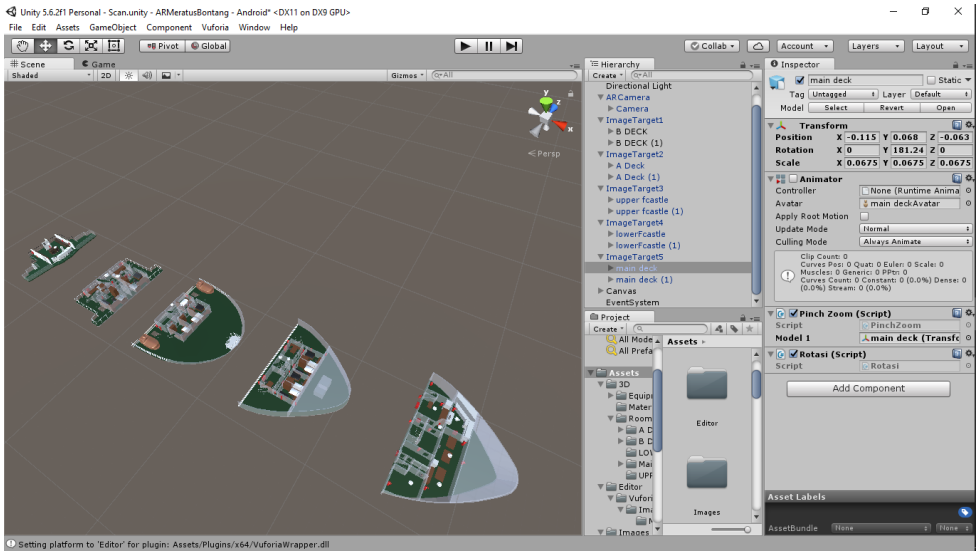


Figure 4. 16 3D Model Rendering

After the required components added to the object, the markers that have been uploaded on the server will be loaded in the Unity editor. These markers must be positioned according to the correct 3D model, so that the marker will visualize the corresponding model.

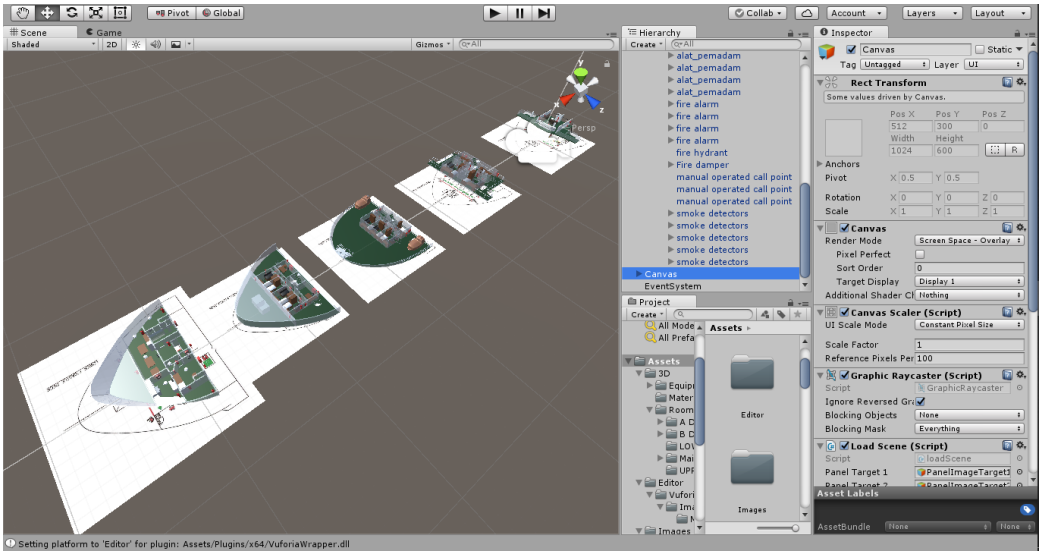


Figure 4. 17 Marker Pattern Tracking

4.2.3.3. Application User Interface

User Interface (UI) is a communication mechanism between user with the system. The purpose of the user interface is to communicate to users the features available so that the system can be understood and can be operated easily.

Figure 4. 18 Application User Interface

In figure 4.18, the main menu UI of the application consist of three main features, which are START, HOW TO USE, and ABOUT. Start menu is the main

feature of the application, it will open the camera feature on the smartphone so that the user can capture the marker to be visualized. How to use is a feature that can display user guide to use the application. And the about menu is to show the developer information.

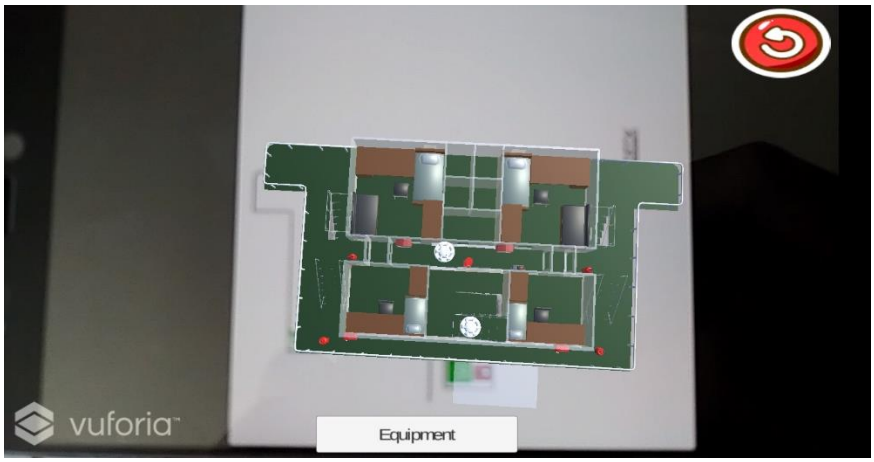


Figure 4. 19 Main Feature User Interface

When START button clicked, the camera feature will appear and ready to detect the marker. Figure 4.16 shows the user interface of main feature of the application.

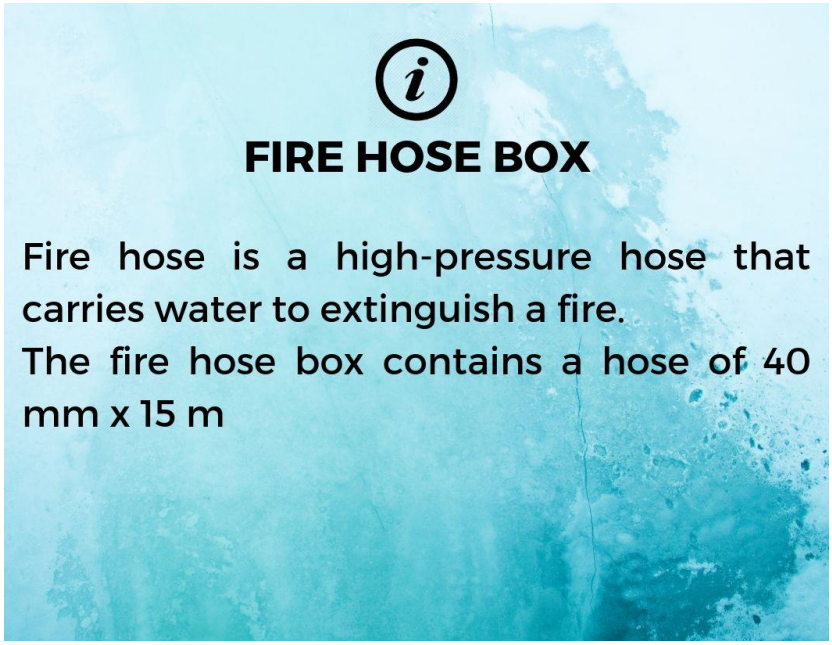


Figure 4. 20 Equipment Information

Table 4. 3 Equipment Location and Quantity Information

"B" DECK	
EQUIPMENT	**QUANTITY**
5 KG DRY POWDER FIRE EXTINGUISHER	2
FIRE ALARM PANEL	1
FIRE HOSE BOX	2
FIRE HYDRANT	2
FIRE PLAN	1
GENERAL/FIRE ALARM BELL	1
MANUAL OPERATED CALL POINT	2
PUSH BUTTON FOR GENERAL ALARM	1
REMOTE CONTROLS FOR EMERGENCY FIRE PUMP	1
REMOTE CONTROLS FOR FIRE PUMP	1
SMOKE DETECTOR	2

4.2.3.4. Application Test

Application testing is performed to find out the application functionality on several Android devices. The application tested on 3 devices with different specification and operating system version. The list of devices can be seen in the table 4.4.

Table 4. 4 Test Device Specification

No.	Specification
1	• Device Name: LG V30+ • OS Version: Android 8.0.0 (Oreo) • RAM: 4 GB • Screen Resolution: 6.0", 1440x2880 pixels
2	• Device Name: Xiaomi Mi 5 • OS Version: Android 9.0 (Pie) • RAM: 3 GB • Screen Resolution: 5.15", 1080x1920 pixels
3	• Device Name: Samsung Galaxy A6+ (2018) • OS Version: Android 9.0 (Pie) • RAM: 4 GB • Screen Resolution: 6.0", 1080x2220 pixels

The aspects tested include functionality, accuracy, menu and button features, etc. The test results can be seen in table 4.5.

Table 4. 5 Test Device Result

No.	Testing Component	Test Device Result		
		Device 1	Device 2	Device 3
1	Run the Application	✓	✓	✓
2	Open “Start” Menu	✓	✓	✓
3	Open “How to Use” Menu	✓	✓	✓
4	Open “About” Menu	✓	✓	✓
5	Scan Markers	✓	✓	✓
6	Zoom and Rotate 3D Model	✓	✓	✓
7	Open Fire-Fighting Equipment Pop-Up	✓	✓	✓
8	Open Equipment Information List	✓	✓	✓

Based on table 4.5, all devices passed the test in every testing component. It supports different operating system version, screen resolution, and RAM availability of the device. The main feature of the application which is the augmented reality model also can visualize the 5 different decks of ship smoothly without any error or bugs found.

In the testing period, the application was also tested on several Marine Engineering Department students as the user. There are some suggestions obtained from the users for the application that will be shown in chapter five.

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CHAPTER V
CONCLUSION AND SUGGESTION

5.1 Conclusion

Based on the result, the conclusions of this research are:

1. Augmented Reality (AR) application can visualize the fire control plan 3D models of MV. Meratus Bontang on five decks.
2. Each fire-fighting equipment can be displayed alongside the information and the location of the object.
3. Utilizing AR is possible to be used as educational media to get precise information relating to the locations, object, and quantity.

5.2 Suggestions

Suggestions of the thesis are:

1. The application has been able to visualize the fire control plan 3D model in an attractive form. But the application only visualizes the superstructure of a ship, not in a complete form of ship building including its engine room, cargo space, and other areas.
2. Pinch to zoom function could be tricky if the user wants to enlarge and zoom out the model. Because when it touches the fire-fighting equipment in the same time, the pop-up information will appear accidentally.
3. This application uses the marker-based method that requires a specific target object to be recognized in the application in order to display the 3D model of ship. This can be an aspect that needs attention in terms of the flexibility in using the application.
4. The application is an early development of augmented reality application to be applied in a ship model. There are many improvements that can be done by adding many features to the further development.

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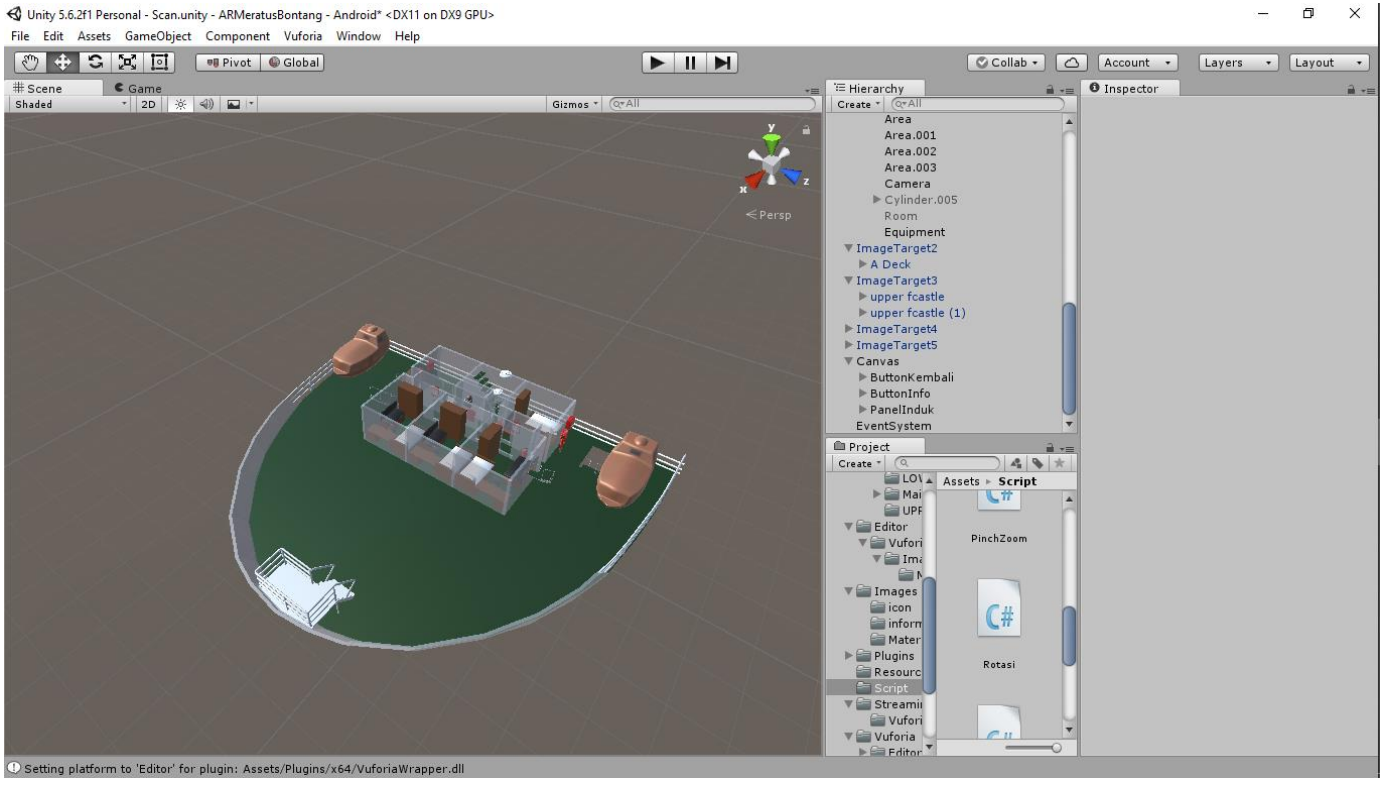
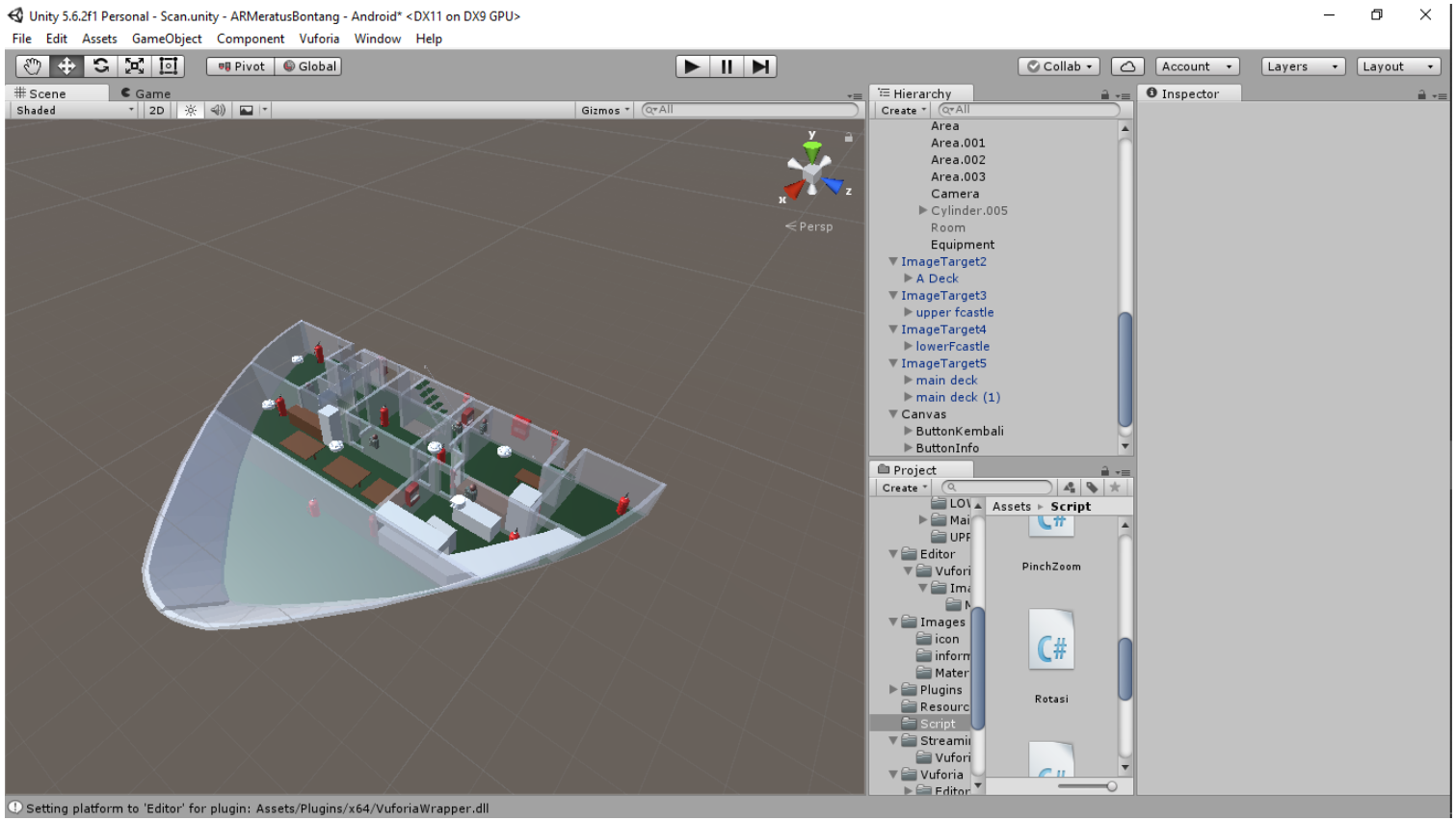
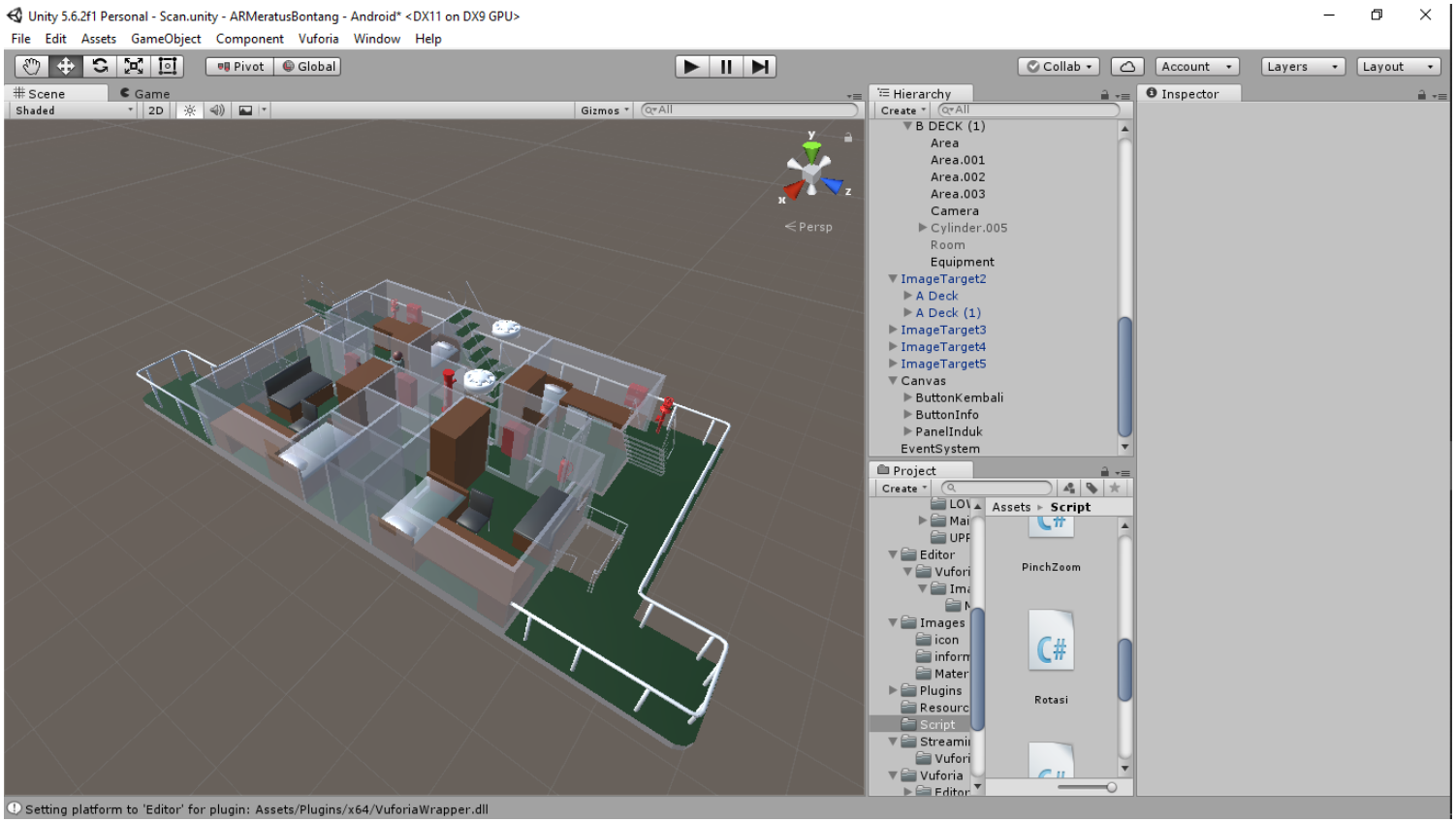
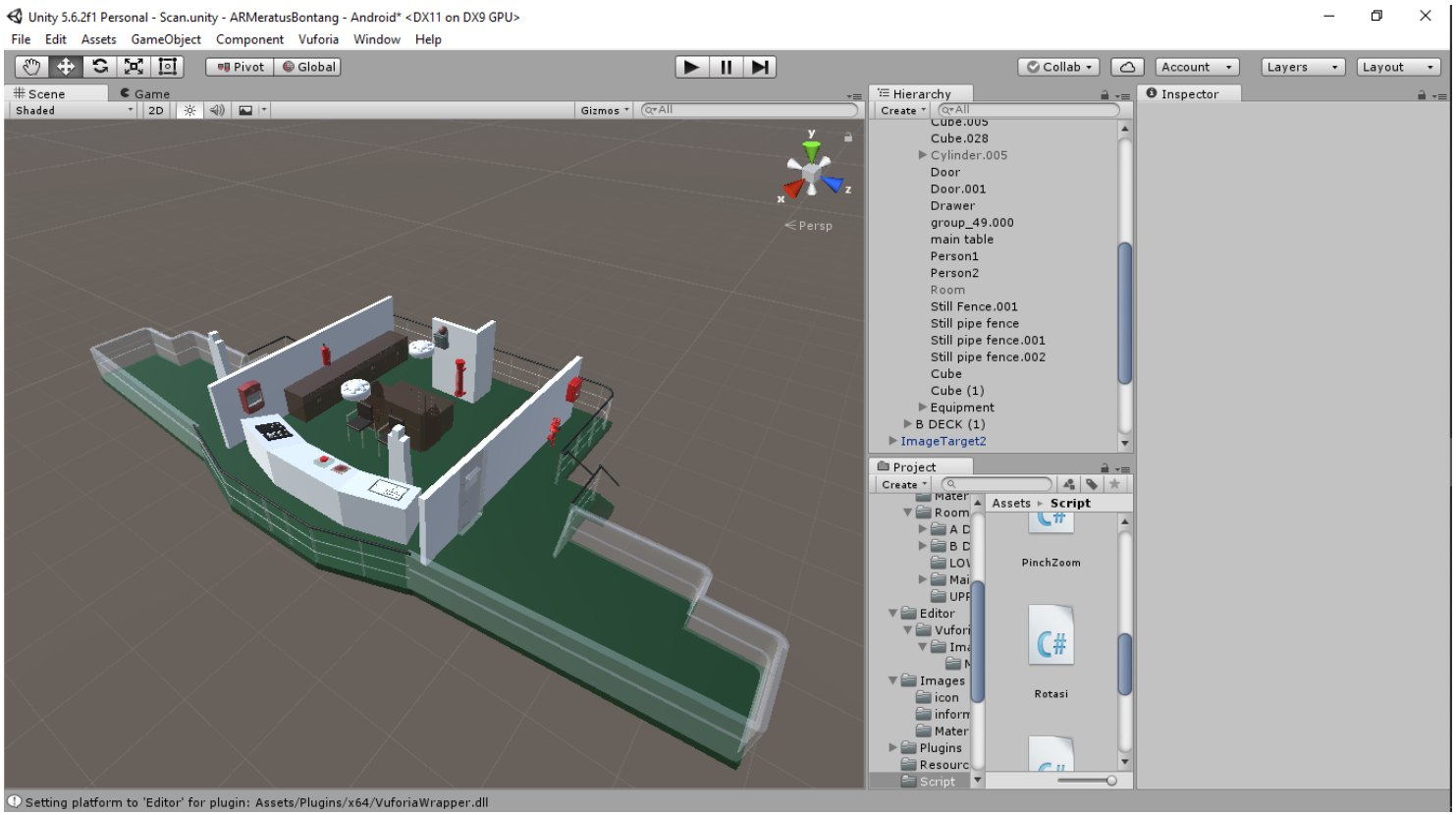
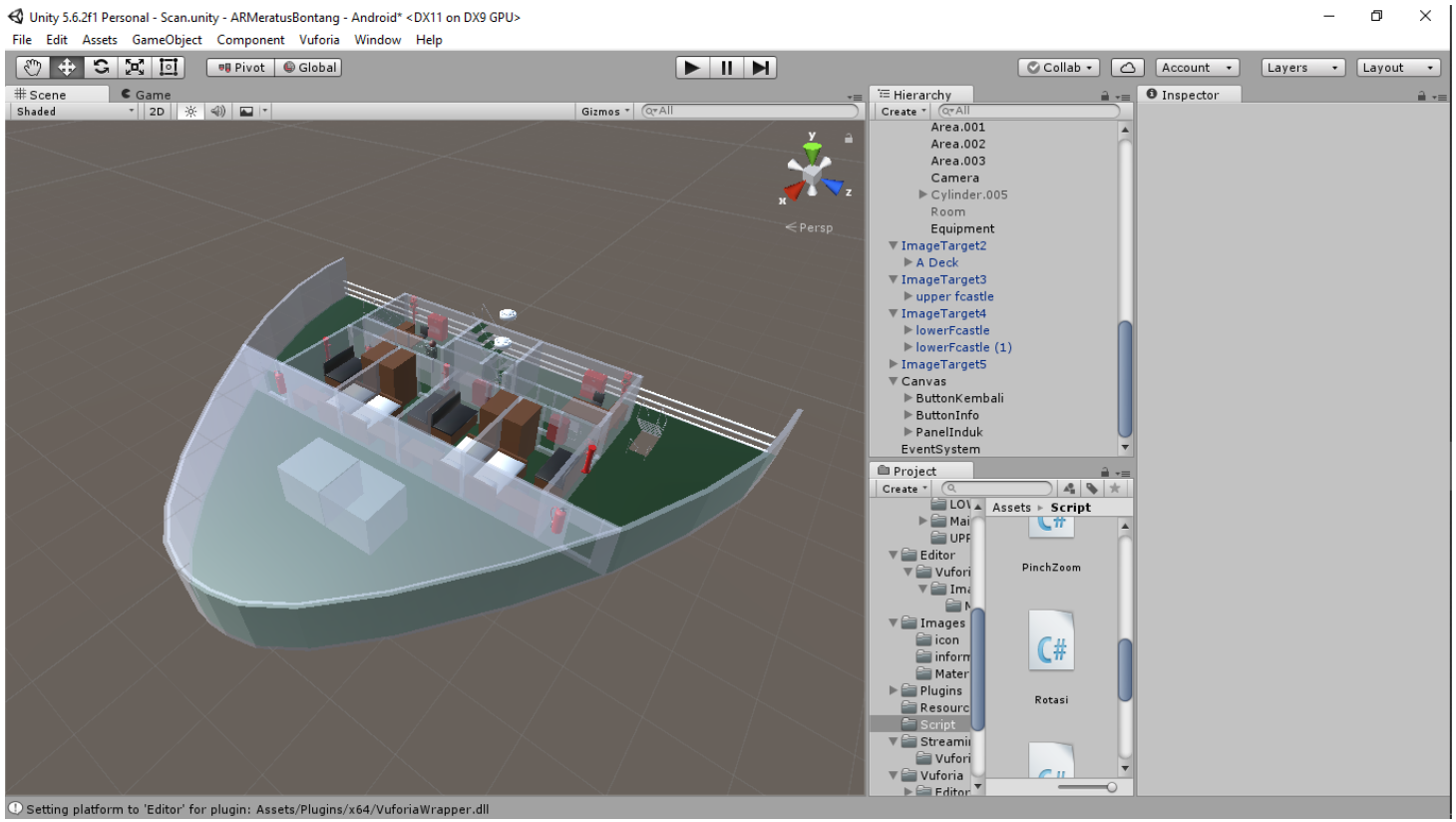
APPENDIX

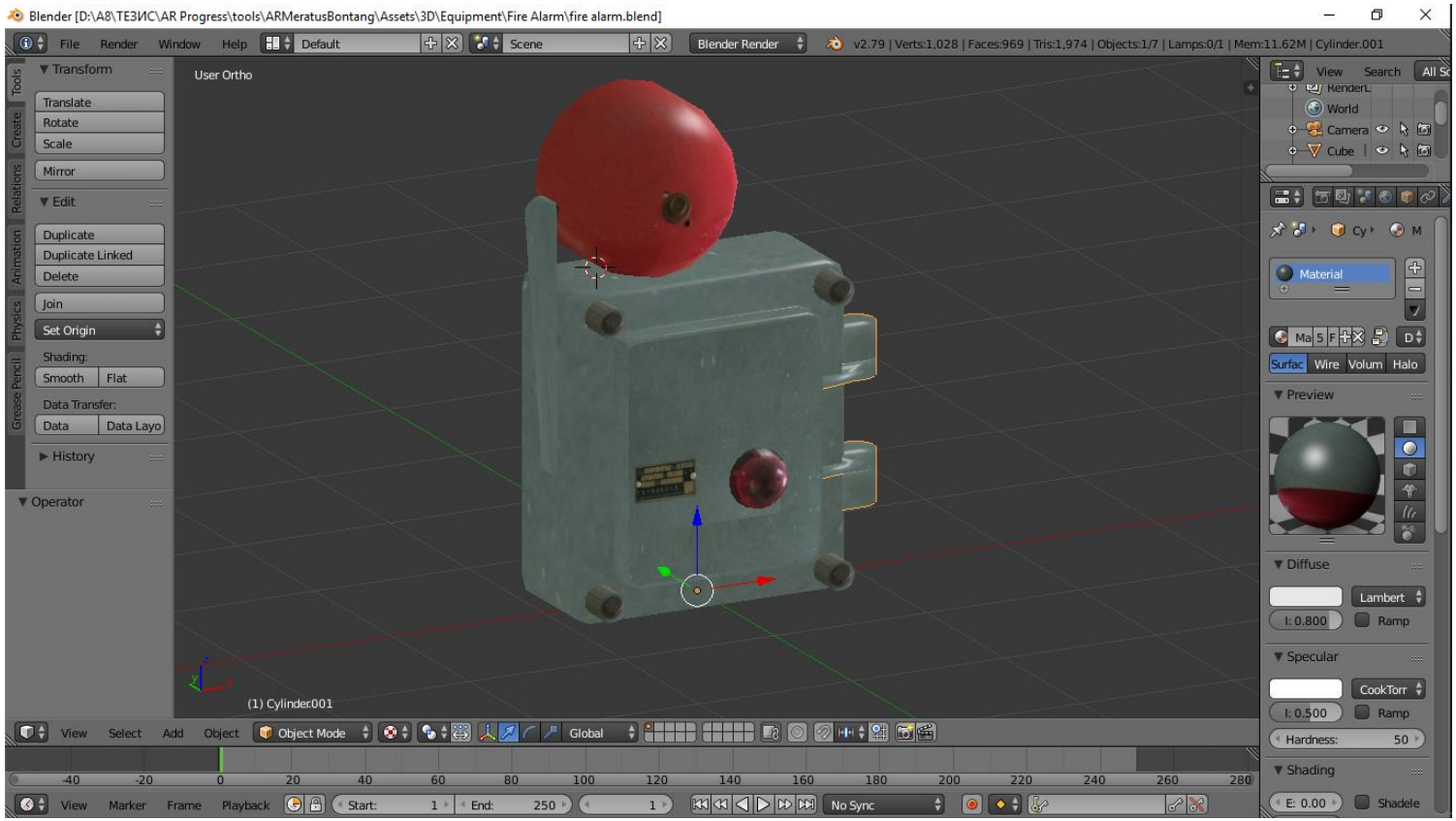

Unity 5.6.2f1 Personal - Scan.unity - ARMeratusBontang - Android* <DX11 on DX9 GPU>
File Edit Assets GameObject Component Vuforia Window Help
Pivot Global
Collab Account Layers Layout
Scene Game
Shaded 2D Gizmos
Persp
Hierarchy
Create
Area
Area.001
Area.002
Area.003
Camera
Cylinder.005
Room
Equipment
ImageTarget2
A Deck
ImageTarget3
upper fcastle
upper fcastle (1)
ImageTarget4
ImageTarget5
Canvas
ButtonKembali
ButtonInfo
PanelInduk
EventSystem
Inspector
Project
Create
Assets ▸ Script
Editor
Images
icon
Plugins
Script
Vuforia
PinchZoom
Rotasi
Setting platform to 'Editor' for plugin: Assets/Plugins/x64/VuforiaWrapper.dll

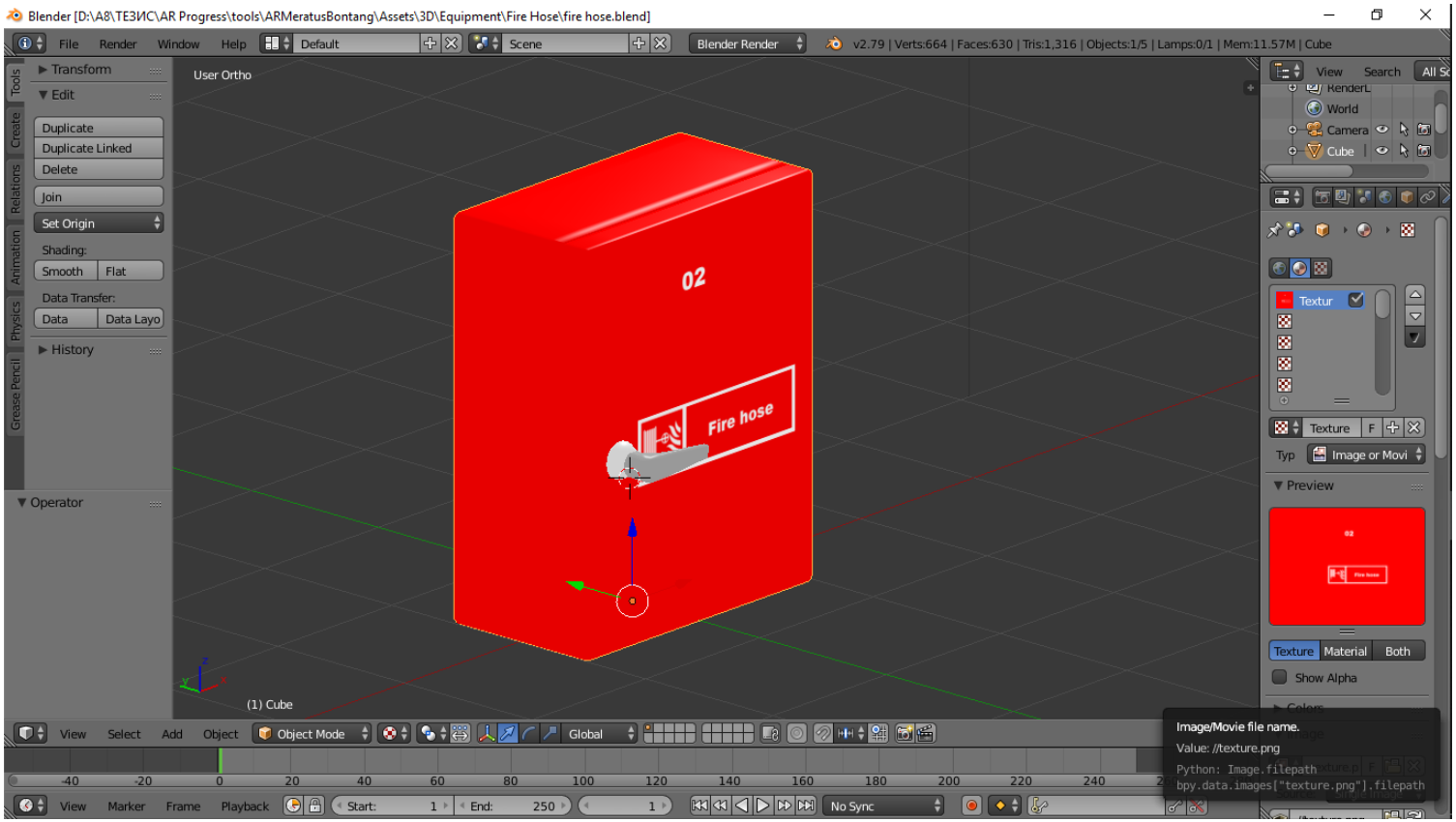

Unity 5.6.2f1 Personal - Scan.unity - ARMeratusBontang - Android* <DX11 on DX9 GPU>
File Edit Assets GameObject Component Vuforia Window Help
Pivot Global
Collab Account Layers Layout
Scene Game
Shaded 2D Gizmos All
Persp
Hierarchy
Create All
Area
Area.001
Area.002
Area.003
Camera
Cylinder.005
Room
Equipment
ImageTarget2
A Deck
ImageTarget3
upper fcastle
ImageTarget4
lowerFcastle
ImageTarget5
main deck
main deck (1)
Canvas
ButtonKembali
ButtonInfo
Inspector
Project
Create
Assets ▸ Script
Editor
Images
icon
Plugins
Script
Vuforia
PinchZoom
Rotasi
Setting platform to 'Editor' for plugin: Assets/Plugins/x64/VuforiaWrapper.dll

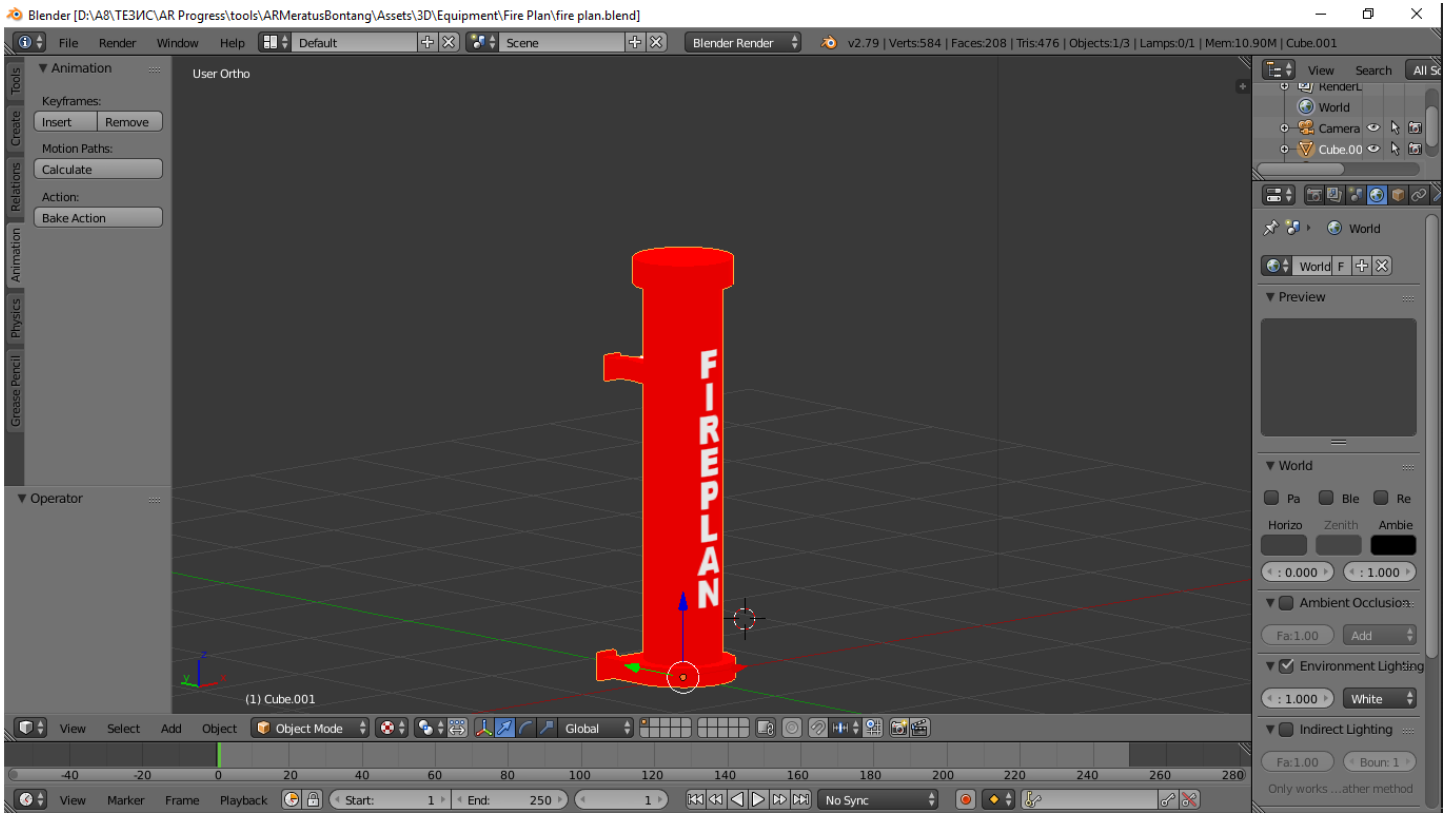

Unity 5.6.2f1 Personal - Scan.unity - ARMeratusBontang - Android* <DX11 on DX9 GPU>
File Edit Assets GameObject Component Vuforia Window Help
Pivot Global
Collab Account Layers Layout
Scene Game
Shaded 2D Gizmos
Persp
Hierarchy
Create
B DECK (1)
Area
Area.001
Area.002
Area.003
Camera
Cylinder.005
Room
Equipment
ImageTarget2
A Deck
A Deck (1)
ImageTarget3
ImageTarget4
ImageTarget5
Canvas
ButtonKembali
ButtonInfo
PanelInduk
EventSystem
Inspector
Project
Create
Assets ▸ Script
Editor
Images
icon
Plugins
Script
Vuforia
PinchZoom
Rotasi
Setting platform to 'Editor' for plugin: Assets/Plugins/x64/VuforiaWrapper.dll

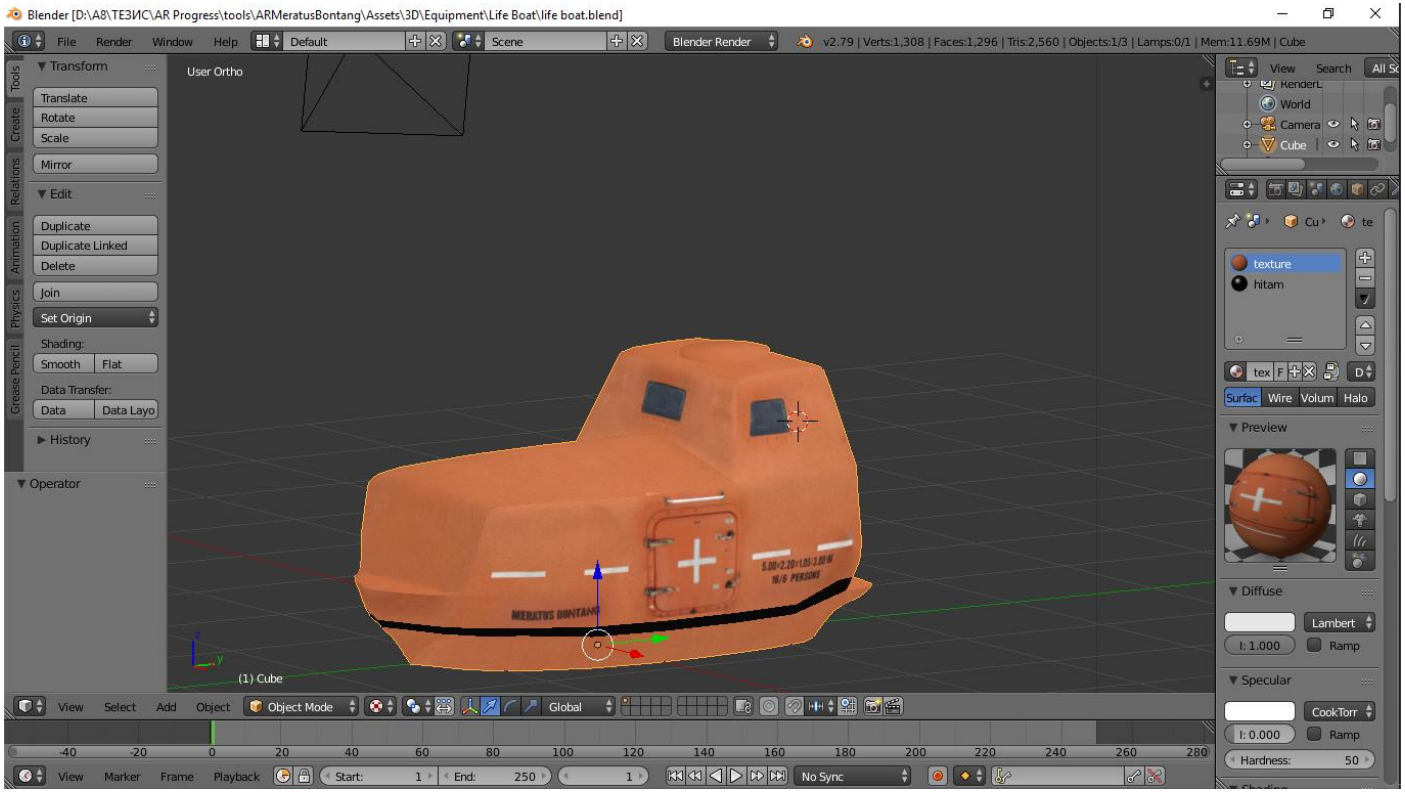

Unity 5.6.2f1 Personal - Scan.unity - ARMeratusBontang - Android* <DX11 on DX9 GPU>
File Edit Assets GameObject Component Vuforia Window Help
Pivot Global
Collab Account Layers Layout
Scene Game
Shaded 2D Gizmos
Persp
Hierarchy
Create
Cube.028
Cylinder.005
Door
Door.001
Drawer
group_49.000
main table
Person1
Person2
Room
Still Fence.001
Still pipe fence
Still pipe fence.001
Still pipe fence.002
Cube
Cube (1)
Equipment
B DECK (1)
ImageTarget2
Inspector
Project
Create
Assets Script
PinchZoom
Rotasi
Editor
Images
icon
Plugins
Script
Setting platform to 'Editor' for plugin: Assets/Plugins/x64/VuforiaWrapper.dll


Unity 5.6.2f1 Personal - Scan.unity - ARMeratusBontang - Android* <DX11 on DX9 GPU>
File Edit Assets GameObject Component Vuforia Window Help
Pivot Global
Collab Account Layers Layout
Scene Game
Shaded 2D Gizmos
Persp
Hierarchy
Create
Area.001
Area.002
Area.003
Camera
Cylinder.005
Room
Equipment
ImageTarget2
A Deck
ImageTarget3
upper fcastle
ImageTarget4
lowerFcastle
lowerFcastle (1)
ImageTarget5
Canvas
ButtonKembali
ButtonInfo
PanelInduk
EventSystem
Inspector
Project
Create
Assets ▸ Script
Editor
Images
icon
Plugins
Script
Vuforia
PinchZoom
Rotasi
Setting platform to 'Editor' for plugin: Assets/Plugins/x64/VuforiaWrapper.dll


Blender [D:\A8\ТЕЗИС\AR Progress\tools\ARMeratusBontang\Assets\3D\Equipment\Fire Alarm\fire alarm.blend]
File Render Window Help Default Scene Blender Render v2.79 | Verts:1,028 | Faces:969 | Tris:1,974 | Objects:1/7 | Lamps:0/1 | Mem:11.62M | Cylinder.001
Transform
Translate
Rotate
Scale
Mirror
Edit
Duplicate
Duplicate Linked
Delete
Join
Set Origin
Shading:
Smooth Flat
Data Transfer:
Data Data Layo
History
Operator
User Ortho
(1) Cylinder001
View Search
World
Camera
Cube
Material
Surfac Wire Volum Halo
Preview
Diffuse
Lambert
I: 0.800
Ramp
Specular
CookTorr
I: 0.500
Ramp
Hardness: 50
Shading
E: 0.00
View Select Add Object Object Mode Global
View Marker Frame Playback Start: 1 End: 250 1 No Sync


Blender [D:\A8\ТЕЗИС\AR Progress\tools\ARMeratusBontang\Assets\3D\Equipment\Fire Hose\fire hose.blend]
File Render Window Help Default Scene Blender Render v2.79 | Verts:664 | Faces:630 | Tris:1,316 | Objects:1/5 | Lamps:0/1 | Mem:11.57M | Cube
User Ortho
02
Fire hose
(1) Cube
Transform
Edit
Duplicate
Duplicate Linked
Delete
Join
Set Origin
Shading:
Smooth Flat
Data Transfer:
Data Data Layo
History
Operator
Tools Create Relations Animation Physics Grease Pencil
View Search
World
Camera
Cube
Texture
Image or Movi
Preview
Texture Material Both
Show Alpha
View Select Add Object Object Mode Global
View Marker Frame Playback Start: 1 End: 250 1 No Sync
Image/Movie file name.
Value: //texture.png
Python: Image.filepath
bpy.data.images["texture.png"].filepath


Blender [D:\A8\TE3ИС\AR Progress\tools\ARMeratusBontang\Assets\3D\Equipment\Fire Plan\fire plan.blend]
File Render Window Help Default Scene Blender Render v2.79 | Verts:584 | Faces:208 | Tris:476 | Objects:1/3 | Lamps:0/1 | Mem:10.90M | Cube.001
Animation
Keyframes:
Insert Remove
Motion Paths:
Calculate
Action:
Bake Action
Operator
User Ortho
FIREPLAN
(1) Cube.001
View Select Add Object Object Mode Global
View Search
World
Camera
Cube.00
Preview
World
Ambient Occlusio
Environment Lighting
White
Indirect Lighting
Only works ...ather method
View Marker Frame Playback Start: 1 End: 250 1 No Sync


Blender [D:\A8\ТЕЗИС\AR Progress\tools\ARMeratusBontang\Assets\3D\Equipment\Life Boat\life boat.blend]
File Render Window Help Default Scene Blender Render v2.79 | Verts:1,308 | Faces:1,296 | Tris:2,560 | Objects:1/3 | Lamps:0/1 | Mem:11.69M | Cube
Tools Create Relations Animation Physics Grease Pencil
Transform
Translate
Rotate
Scale
Mirror
Edit
Duplicate
Duplicate Linked
Delete
Join
Set Origin
Shading:
Smooth Flat
Data Transfer:
Data Data Layo
History
Operator
User Ortho
MERATUS BONTANG
(1) Cube
View Search
World
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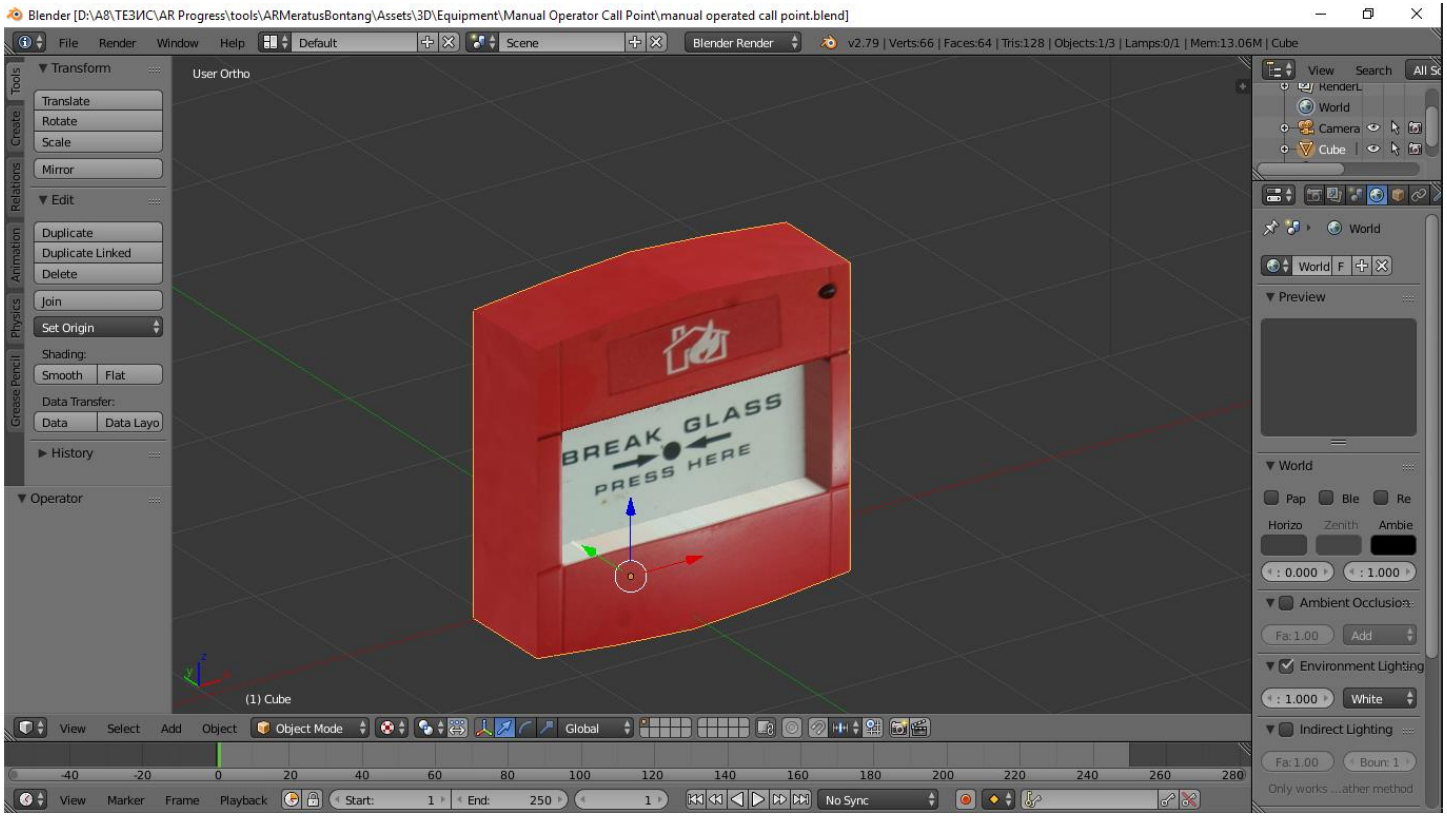
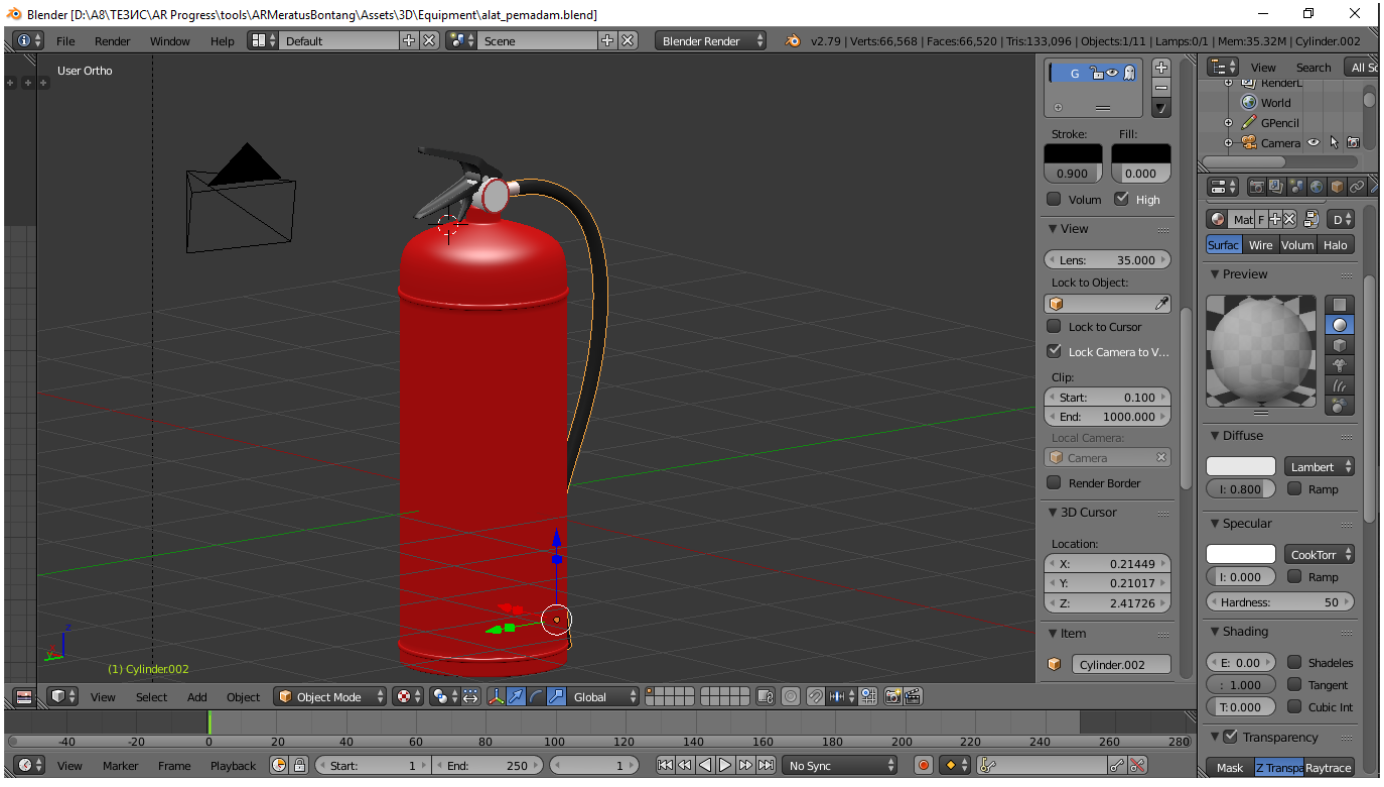
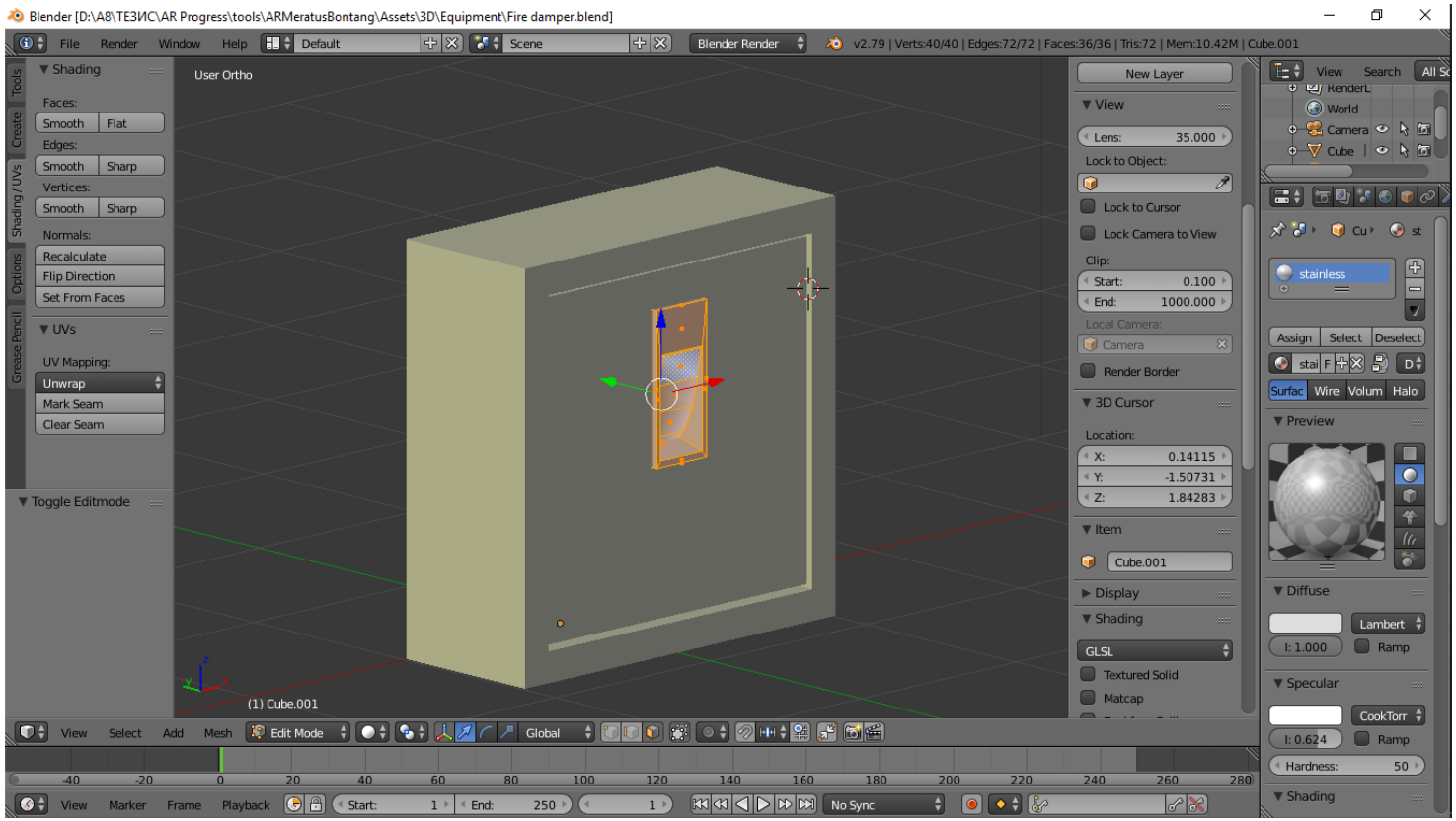
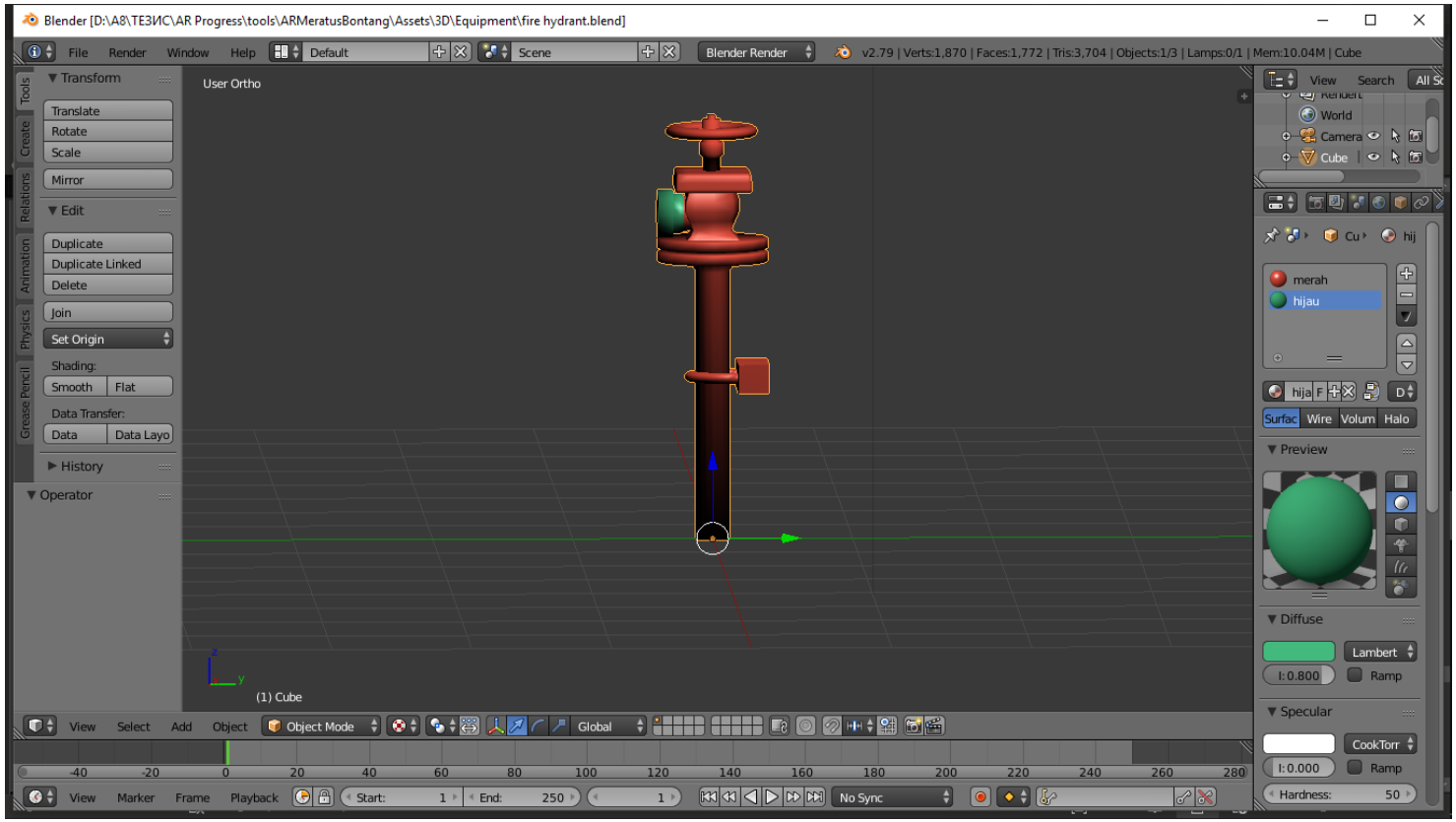
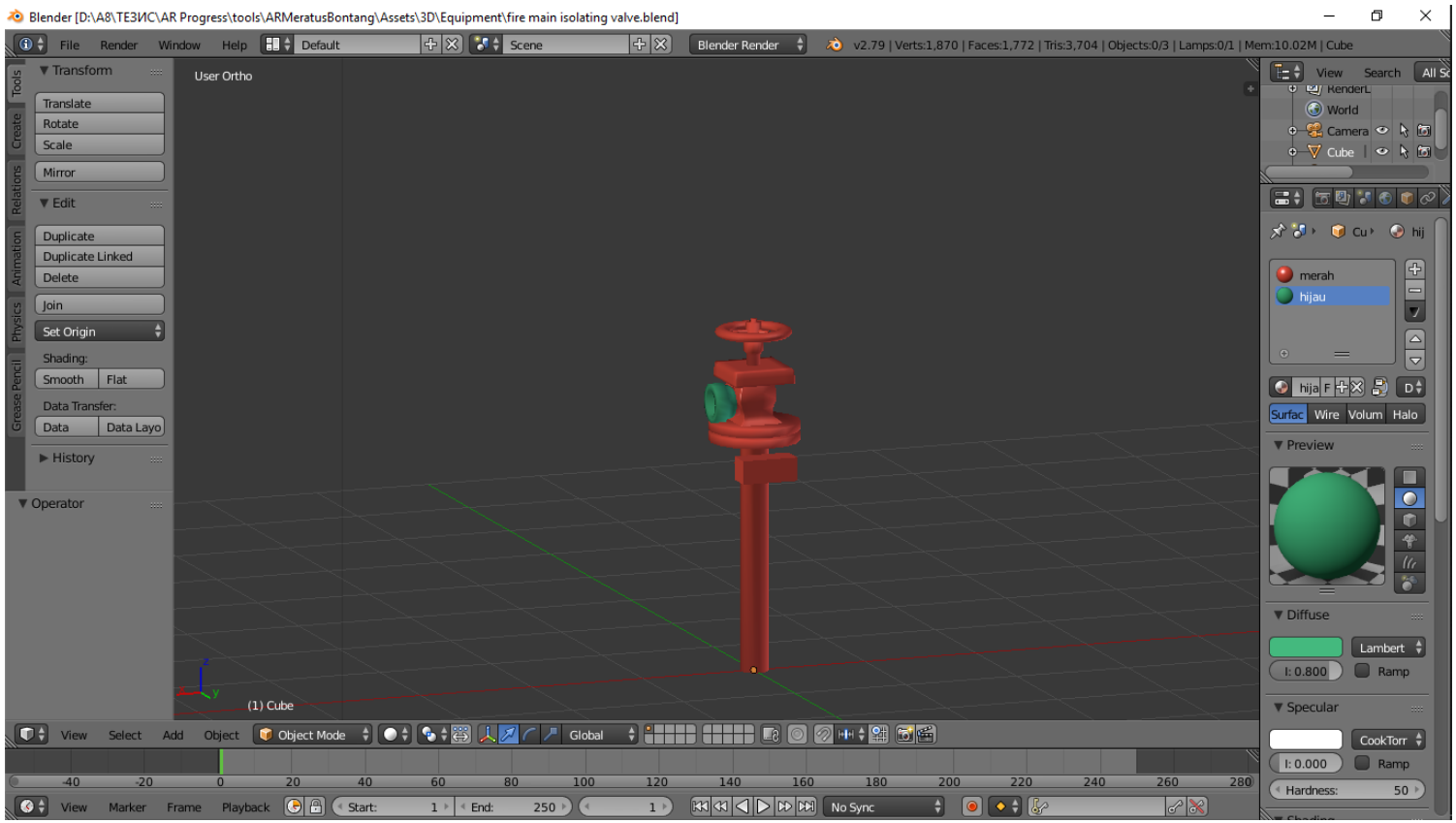
Cube
texture
hitam
Surfac Wire Volum Halo
Preview
Diffuse
Lambert
I: 1.000
Ramp
Specular
CookTorr
I: 0.000
Ramp
Hardness: 50
View Select Add Object Object Mode Global
View Marker Frame Playback Start: 1 End: 250 1 No Sync

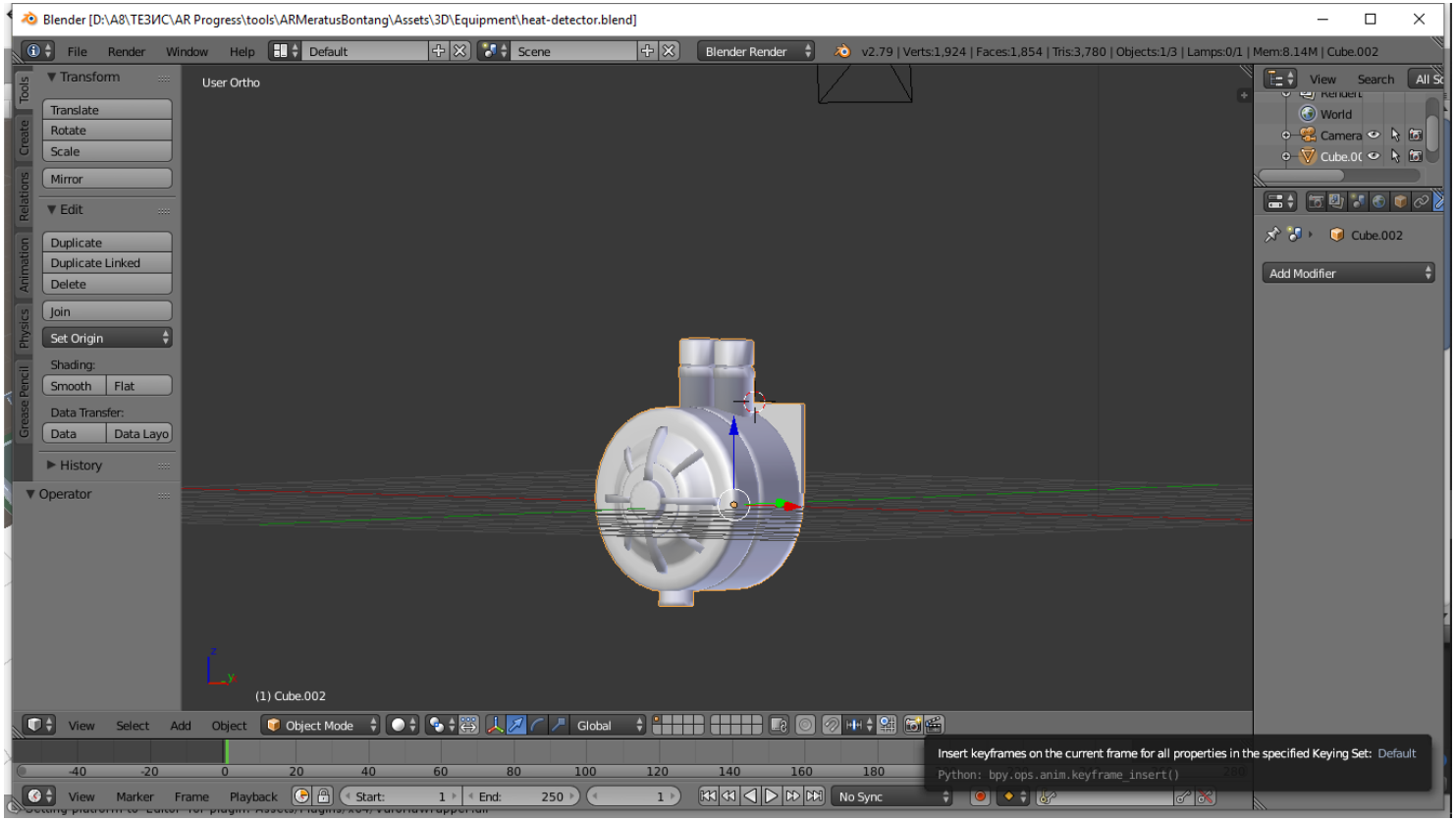

Blender [D:\A8\ТЕЗИС\AR Progress\tools\ARMeratusBontang\Assets\3D\Equipment\Manual Operator Call Point\manual operated call point.blend]
File Render Window Help Default Scene Blender Render v2.79 | Verts:66 | Faces:64 | Tris:128 | Objects:1/3 | Lamps:0/1 | Mem:13.06M | Cube
User Ortho
Transform
Translate
Rotate
Scale
Mirror
Edit
Duplicate
Duplicate Linked
Delete
Join
Set Origin
Shading:
Smooth Flat
Data Transfer:
History
Operator
BREAK GLASS
PRESS HERE
(1) Cube
View Search
World
Camera
Cube
Preview
Ambient Occlusion
Environment Lighting
White
Indirect Lighting
View Select Add Object Object Mode Global
View Marker Frame Playback Start: 1 End: 250 No Sync

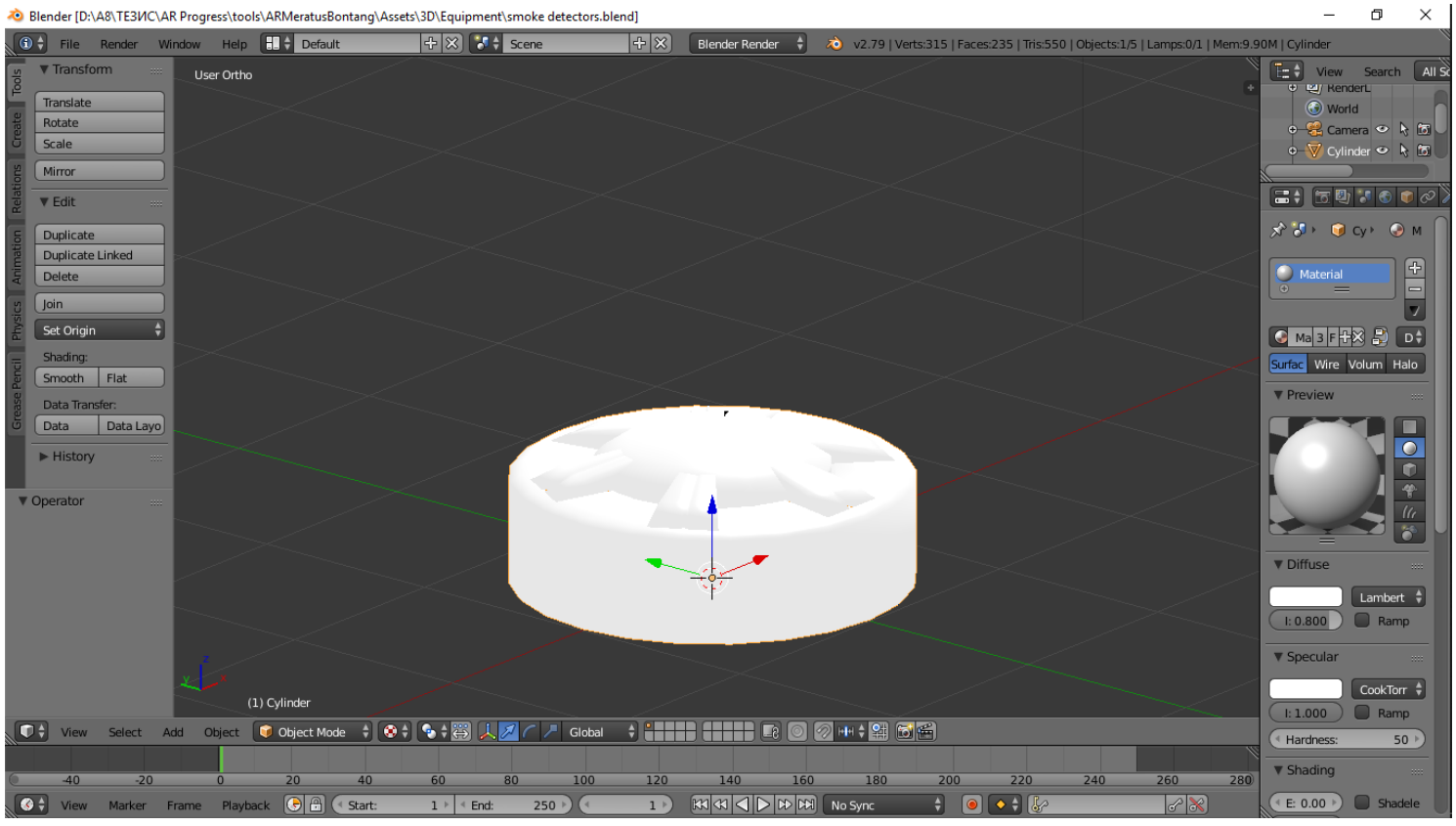

Blender [D:\A8\ТЕЗИС\AR Progress\tools\ARMeratusBontang\Assets\3D\Equipment\alat_pemadam.blend]
File Render Window Help Default Scene Blender Render v2.79 | Verts:66,568 | Faces:66,520 | Tris:133,096 | Objects:1/11 | Lamps:0/1 | Mem:35.32M | Cylinder.002
User Ortho
(1) Cylinder.002
View Select Add Object Object Mode Global
View Marker Frame Playback Start: 1 End: 250 1 No Sync
Stroke: Fill:
0.900 0.000
Volum High
View
Lens: 35.000
Lock to Object:
Lock to Cursor
Lock Camera to V...
Clip:
Start: 0.100
End: 1000.000
Local Camera:
Camera
Render Border
3D Cursor
Location:
X: 0.21449
Y: 0.21017
Z: 2.41726
Item
Cylinder.002
View Search
World
GPencil
Camera
Surfac Wire Volum Halo
Preview
Diffuse
Lambert
I: 0.800
Ramp
Specular
CookTorr
I: 0.000
Ramp
Hardness: 50
Shading
E: 0.00
: 1.000
T: 0.000
Shadeles
Tangent
Cubic Int
Transparency
Mask Z Transpa Raytrace

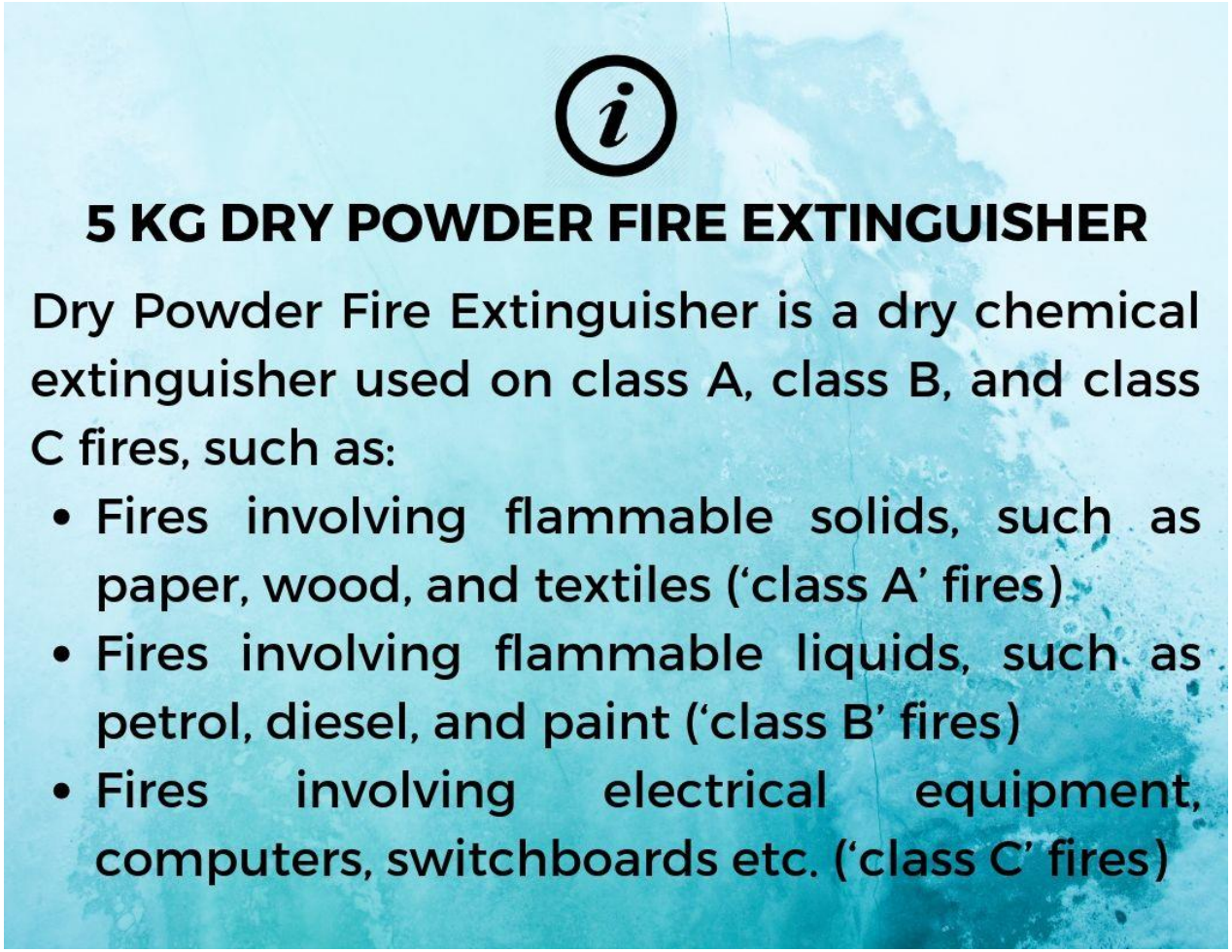

Blender [D:\АВ\ТЕЗИС\AR Progress\tools\ARMeratusBontang\Assets\3D\Equipment\Fire damper.blend]
File Render Window Help Default Scene Blender Render v2.79 | Verts:40/40 | Edges:72/72 | Faces:36/36 | Tris:72 | Mem:10.42M | Cube.001
Tools Create Shading / UVs Options Grease Pencil
Shading
Faces:
Smooth Flat
Edges:
Smooth Sharp
Vertices:
Smooth Sharp
Normals:
Recalculate
Flip Direction
Set From Faces
UVs
UV Mapping:
Unwrap
Mark Seam
Clear Seam
Toggle Editmode
User Ortho
(1) Cube.001
New Layer
View
Lens: 35.000
Lock to Object:
Lock to Cursor
Lock Camera to View
Clip:
Start: 0.100
End: 1000.000
Local Camera:
Camera
Render Border
3D Cursor
Location:
X: 0.14115
Y: -1.50731
Z: 1.84283
Item
Cube.001
Display
Shading
GLSL
Textured Solid
Matcap
View Search All Sc
RenderL
World
Camera
Cube
Cu st
stainless
Assign Select Deselect
stai F D
Surfac Wire Volum Halo
Preview
Diffuse
Lambert
I: 1.000
Ramp
Specular
CookTorr
I: 0.624
Ramp
Hardness: 50
Shading
View Select Add Mesh Edit Mode Global
-40 -20 0 20 40 60 80 100 120 140 160 180 200 220 240 260 280
View Marker Frame Playback Start: 1 End: 250 1 No Sync

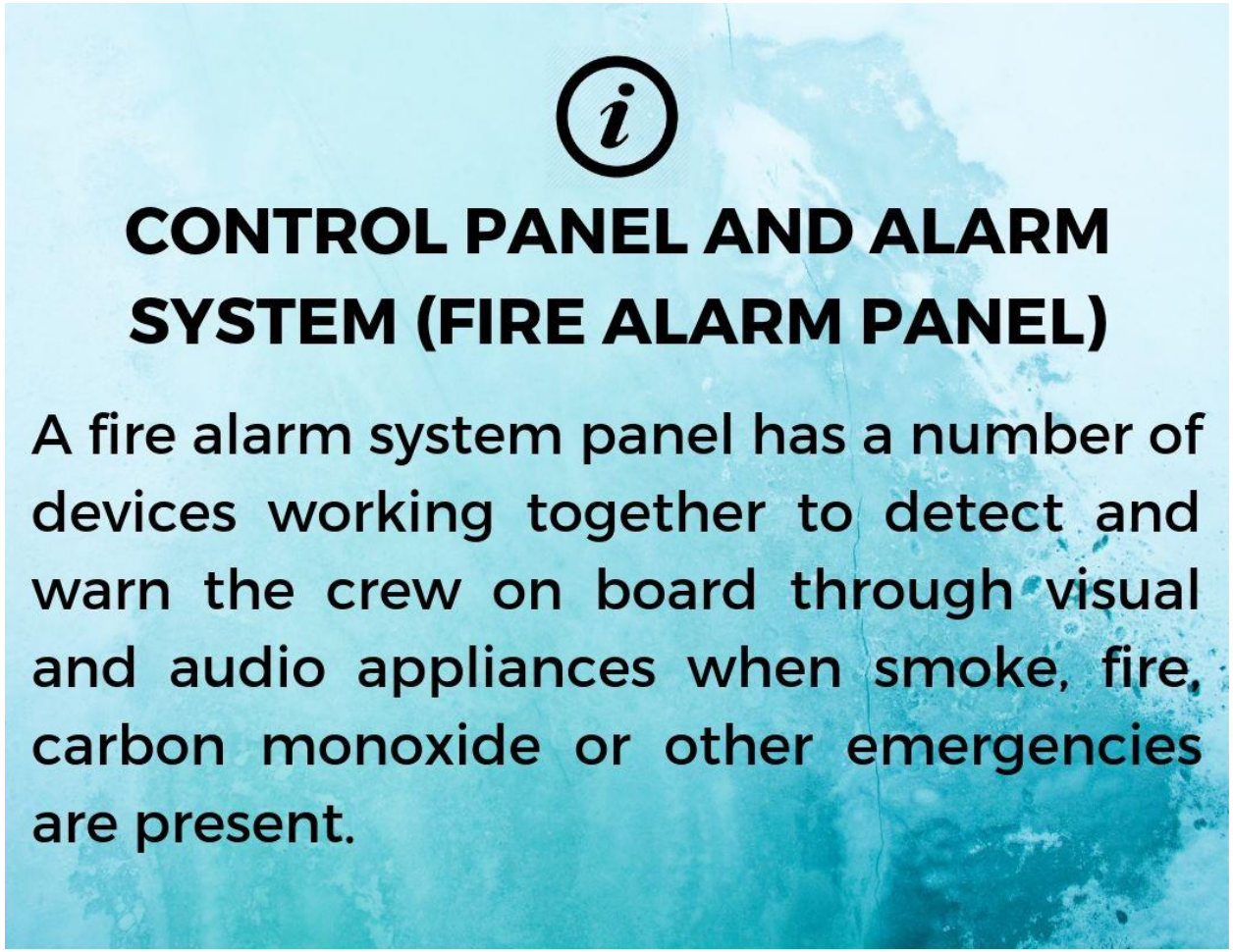

Blender [D:\A8\TE3ИС\AR Progress\tools\ARMeratusBontang\Assets\3D\Equipment\fire hydrant.blend]
File Render Window Help Default Scene Blender Render v2.79 | Verts:1,870 | Faces:1,772 | Tris:3,704 | Objects:1/3 | Lamps:0/1 | Mem:10.04M | Cube
Transform
Translate
Rotate
Scale
Mirror
Edit
Duplicate
Duplicate Linked
Delete
Join
Set Origin
Shading:
Smooth Flat
Data Transfer:
Data Data Layo
History
Operator
User Ortho
(1) Cube
View Search
World
Camera
Cube
merah
hijau
Preview
Diffuse
Lambert
Ramp
Specular
CookTorr
Ramp
Hardness: 50
View Select Add Object Object Mode Global
View Marker Frame Playback Start: 1 End: 250 1 No Sync


Blender [D:\A8\ТЕЗИС\AR Progress\tools\ARMeratusBontang\Assets\3D\Equipment\fire main isolating valve.blend]
File Render Window Help Default Scene Blender Render v2.79 | Verts:1,870 | Faces:1,772 | Tris:3,704 | Objects:0/3 | Lamps:0/1 | Mem:10.02M | Cube
Transform
Translate
Rotate
Scale
Mirror
Edit
Duplicate
Duplicate Linked
Delete
Join
Set Origin
Shading:
Smooth Flat
Data Transfer:
Data Data Layo
History
Operator
User Ortho
(1) Cube
View Search
World
Camera
Cube
merah
hijau
Surfac Wire Volum Halo
Preview
Diffuse
Lambert
I: 0.800
Ramp
Specular
CookTorr
I: 0.000
Ramp
Hardness: 50
View Select Add Object Object Mode Global
View Marker Frame Playback Start: 1 End: 250 1 No Sync


Blender [D:\A8\ТЕЗИС\AR Progress\tools\ARMeratusBontang\Assets\3D\Equipment\heat-detector.blend]
File Render Window Help Default Scene Blender Render v2.79 | Verts:1,924 | Faces:1,854 | Tris:3,780 | Objects:1/3 | Lamps:0/1 | Mem:8.14M | Cube.002
Tools Create Relations Animation Physics Grease Pencil
Transform
Translate
Rotate
Scale
Mirror
Edit
Duplicate
Duplicate Linked
Delete
Join
Set Origin
Shading:
Smooth Flat
Data Transfer:
Data Data Layo
History
Operator
User Ortho
(1) Cube.002
View Search
World
Camera
Cube.002
Add Modifier
View Select Add Object Object Mode Global
Insert keyframes on the current frame for all properties in the specified Keying Set: Default
Python: bpy.ops.anim.keyframe_insert()
-40 -20 0 20 40 60 80 100 120 140 160 180
View Marker Frame Playback Start: 1 End: 250 1 No Sync

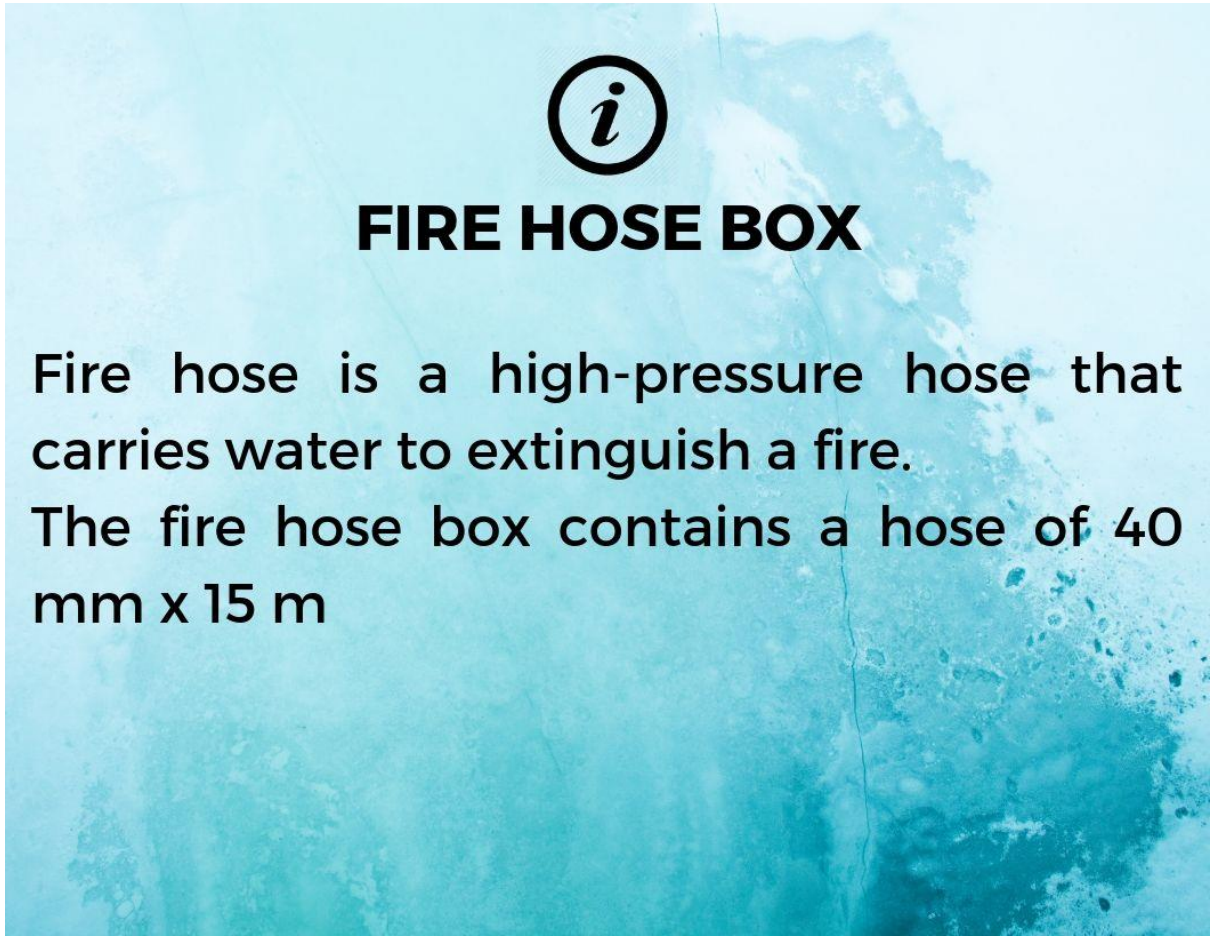

Blender [D:\A8\ТЕЗИС\AR Progress\tools\ARMeratusBontang\Assets\3D\Equipment\smoke detectors.blend]
File Render Window Help Default Scene Blender Render v2.79 | Verts:315 | Faces:235 | Tris:550 | Objects:1/5 | Lamps:0/1 | Mem:9.90M | Cylinder
Transform
Translate
Rotate
Scale
Mirror
Edit
Duplicate
Duplicate Linked
Delete
Join
Set Origin
Shading:
Smooth Flat
Data Transfer:
Data Data Layo
History
Operator
User Ortho
(1) Cylinder
View Search
World
Camera
Cylinder
Material
Surfac Wire Volum Halo
Preview
Diffuse
Lambert
I: 0.800
Ramp
Specular
CookTorr
I: 1.000
Ramp
Hardness: 50
Shading
E: 0.00
Shadele
View Select Add Object Object Mode Global
View Marker Frame Playback Start: 1 End: 250 1 No Sync

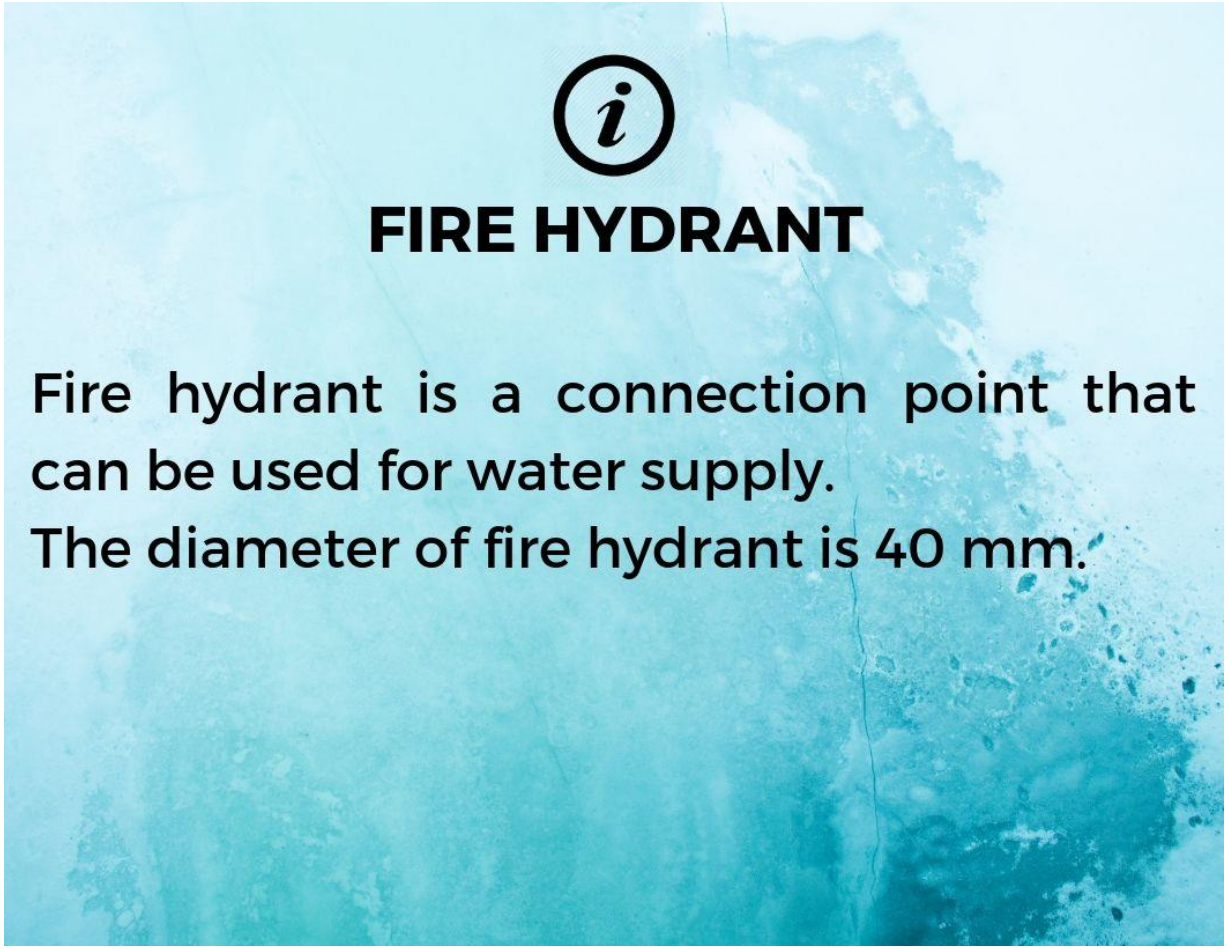

5 KG DRY POWDER FIRE EXTINGUISHER
Dry Powder Fire Extinguisher is a dry chemical extinguisher used on class A, class B, and class C fires, such as:
• Fires involving flammable solids, such as paper, wood, and textiles (‘class A’ fires)
• Fires involving flammable liquids, such as petrol, diesel, and paint (‘class B’ fires)
• Fires involving electrical equipment, computers, switchboards etc. (‘class C’ fires)

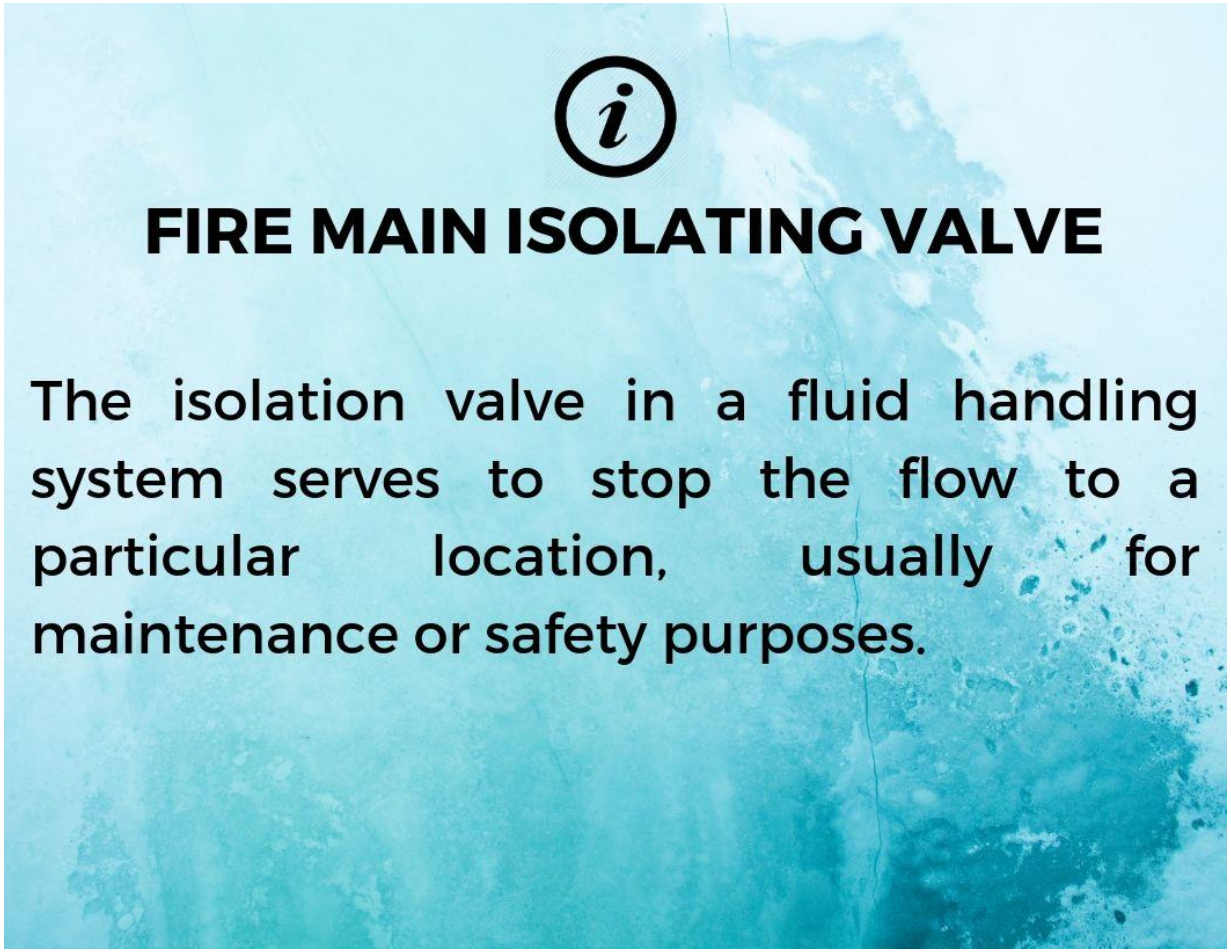

CONTROL PANEL AND ALARM SYSTEM (FIRE ALARM PANEL)
A fire alarm system panel has a number of devices working together to detect and warn the crew on board through visual and audio appliances when smoke, fire, carbon monoxide or other emergencies are present.

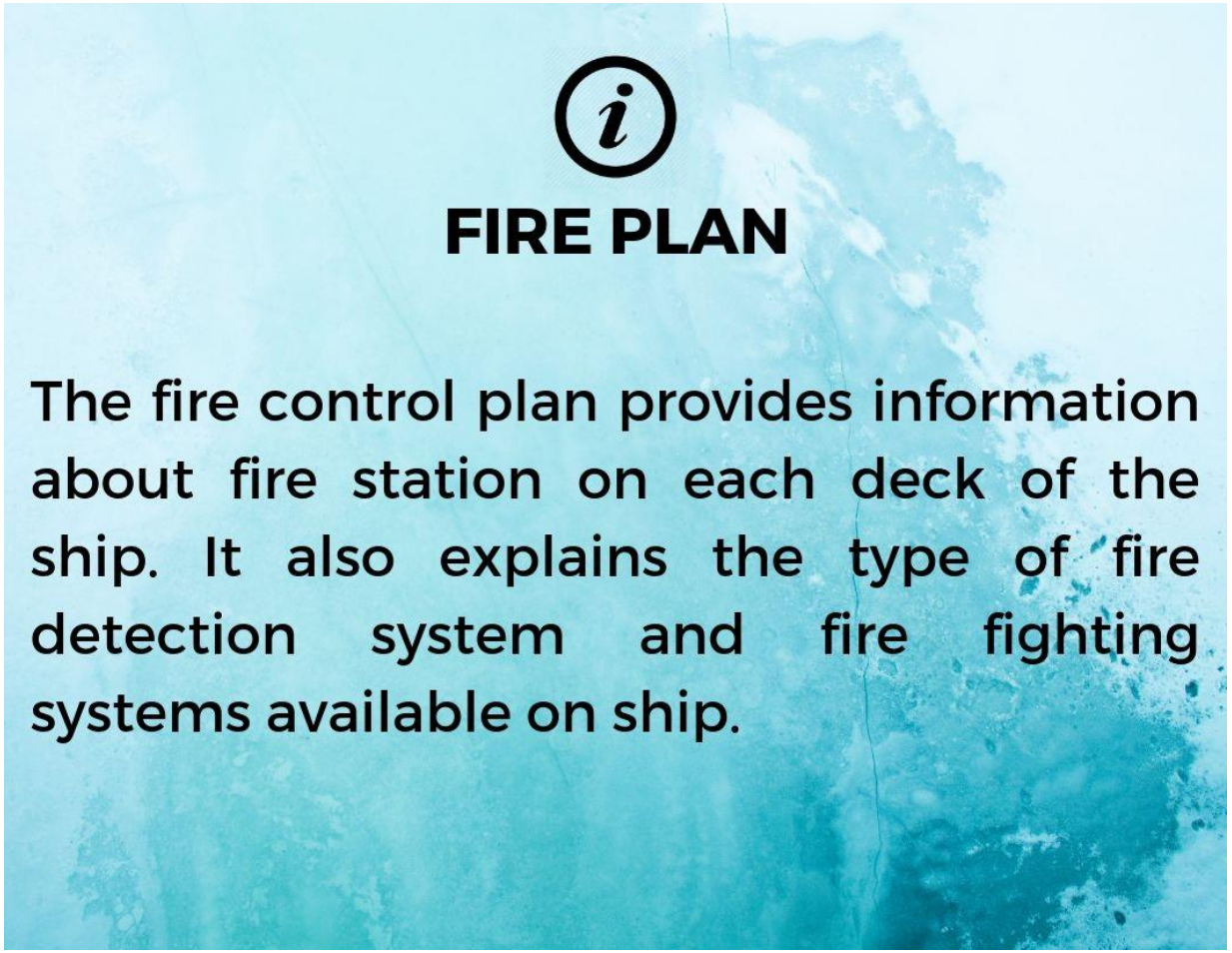
FIRE DAMPER

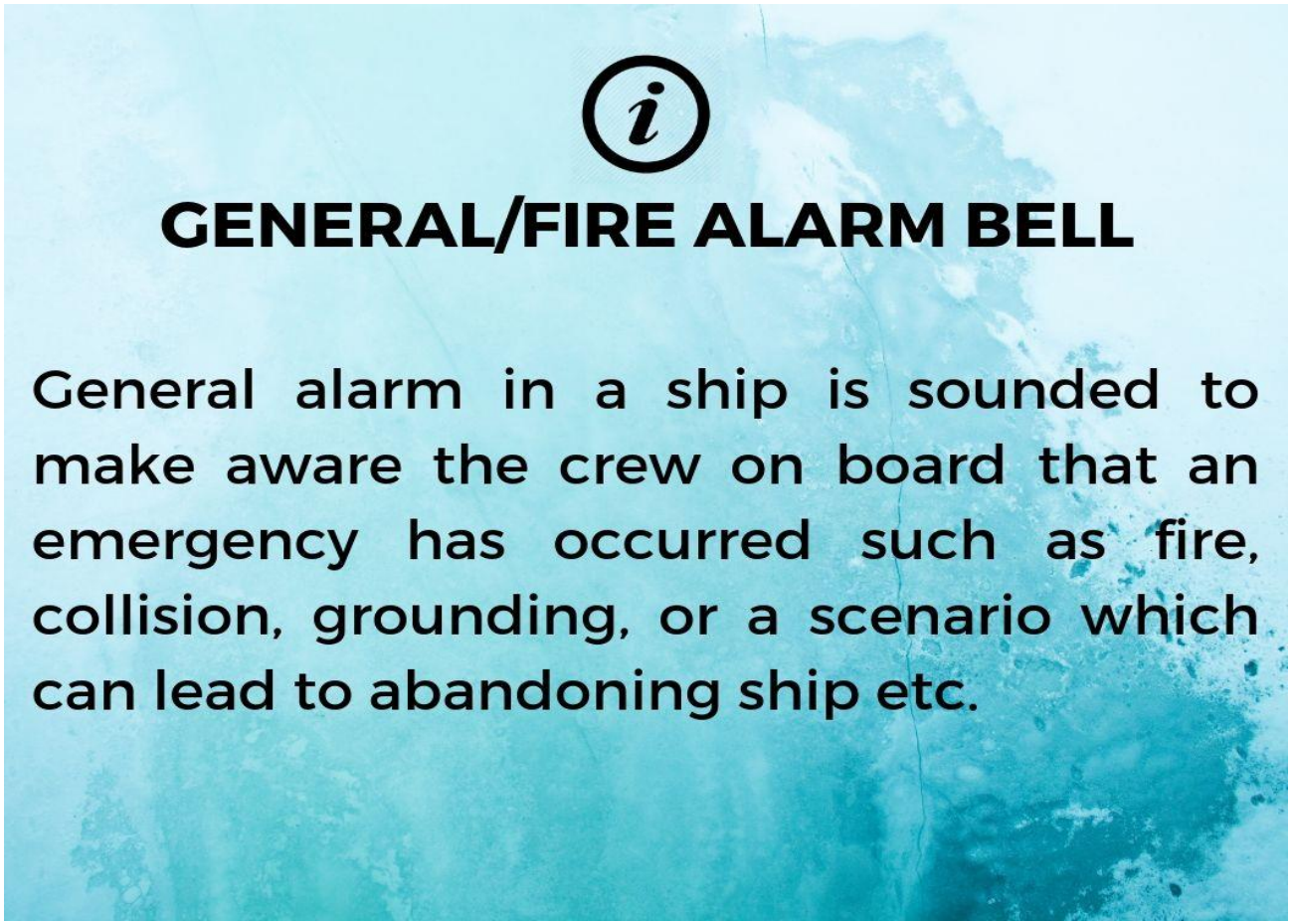
Fire dampers are passive fire protection products used in heating, ventilation, and air conditioning (HVAC) ducts to prevent the spread of fire inside the duct through fire-resistance rated walls and floors.

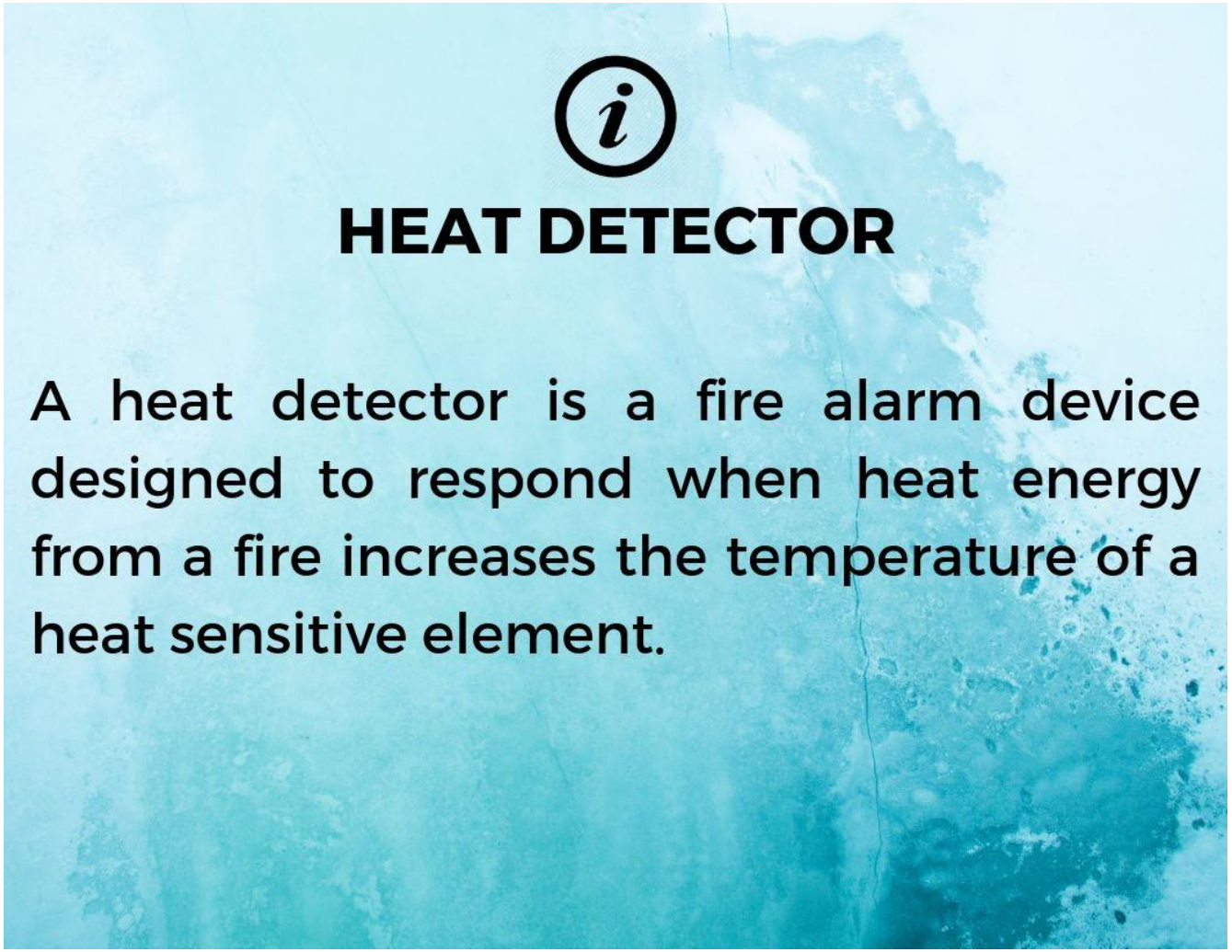

FIRE HOSE BOX
Fire hose is a high-pressure hose that carries water to extinguish a fire.
The fire hose box contains a hose of 40 mm x 15 m

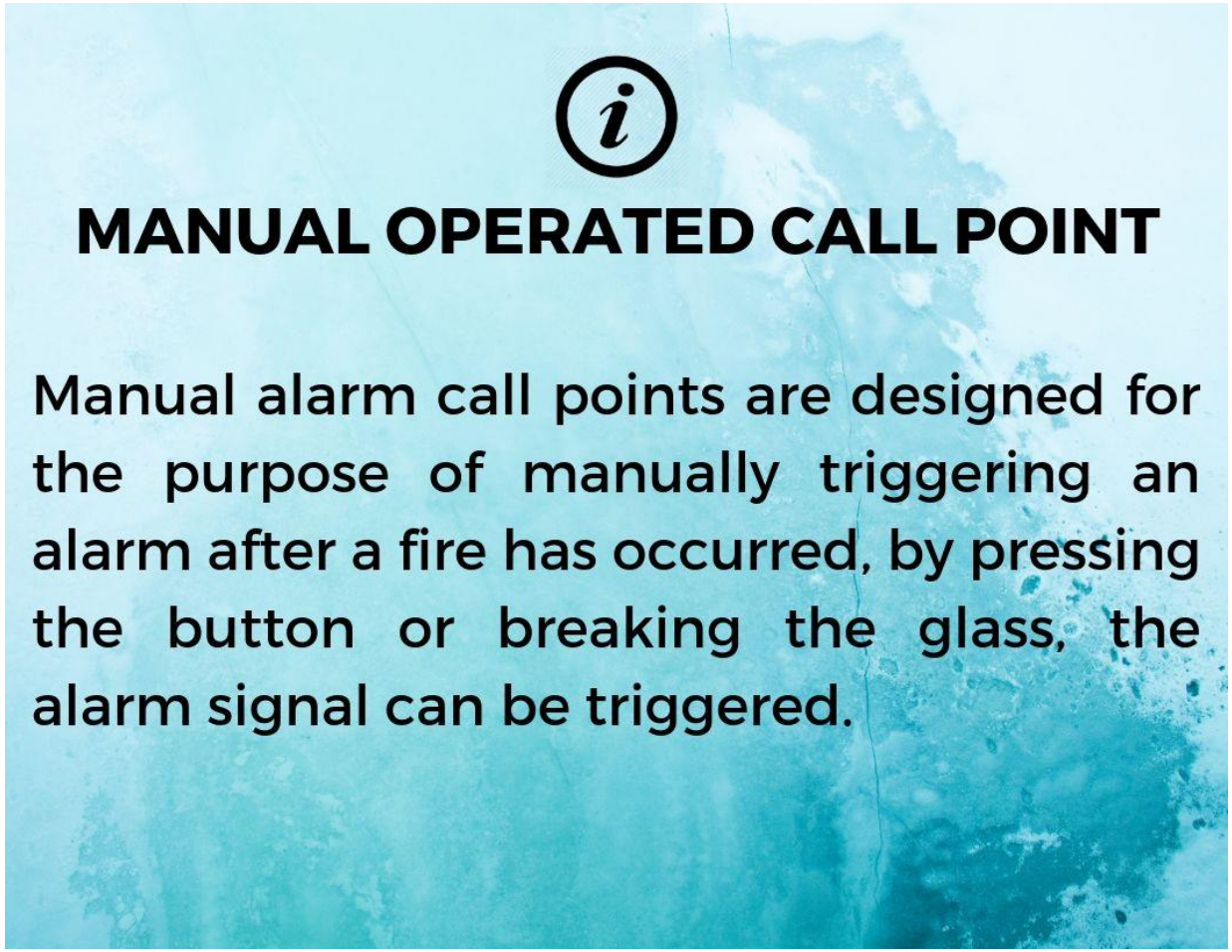

FIRE HYDRANT
Fire hydrant is a connection point that can be used for water supply.
The diameter of fire hydrant is 40 mm.

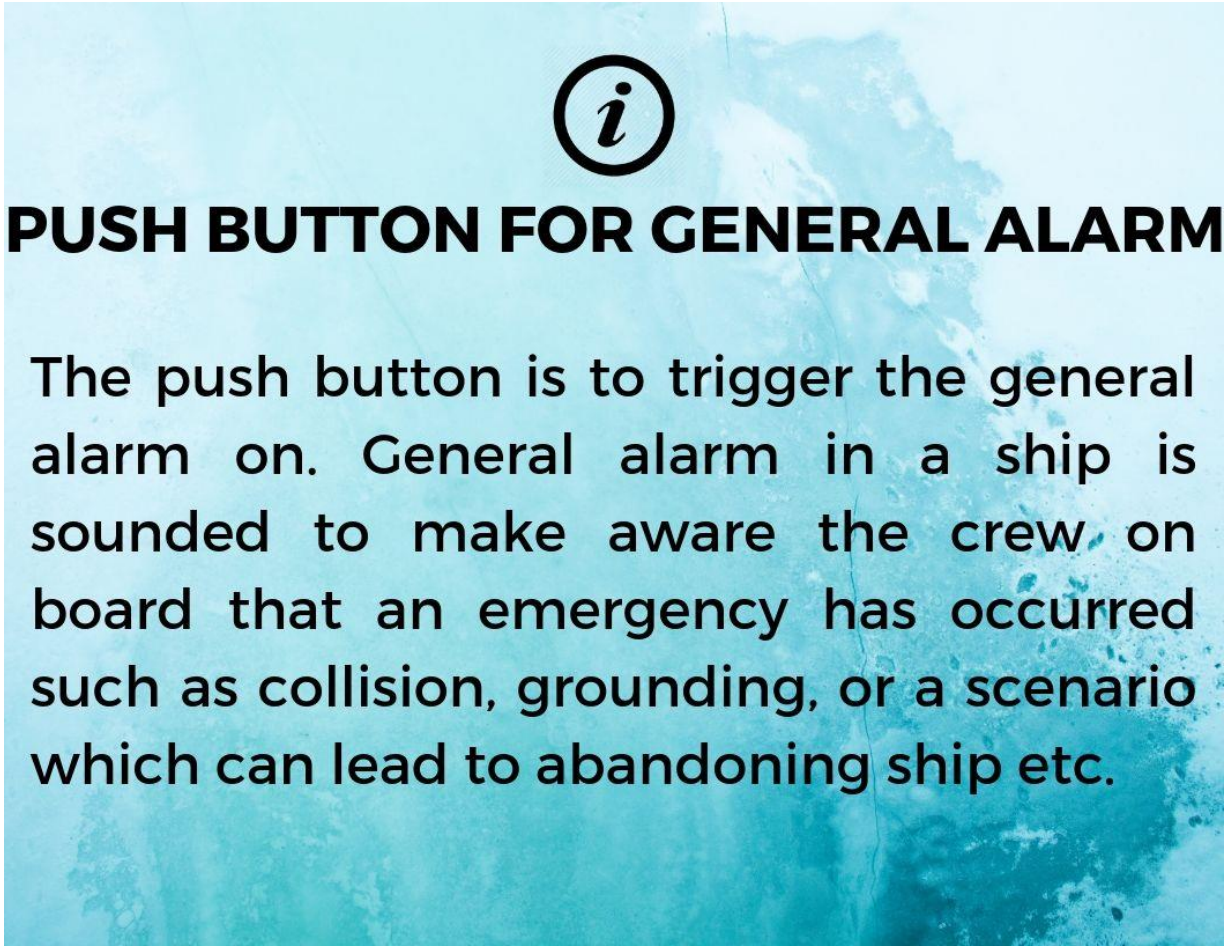

FIRE MAIN ISOLATING VALVE
The isolation valve in a fluid handling system serves to stop the flow to a particular location, usually for maintenance or safety purposes.

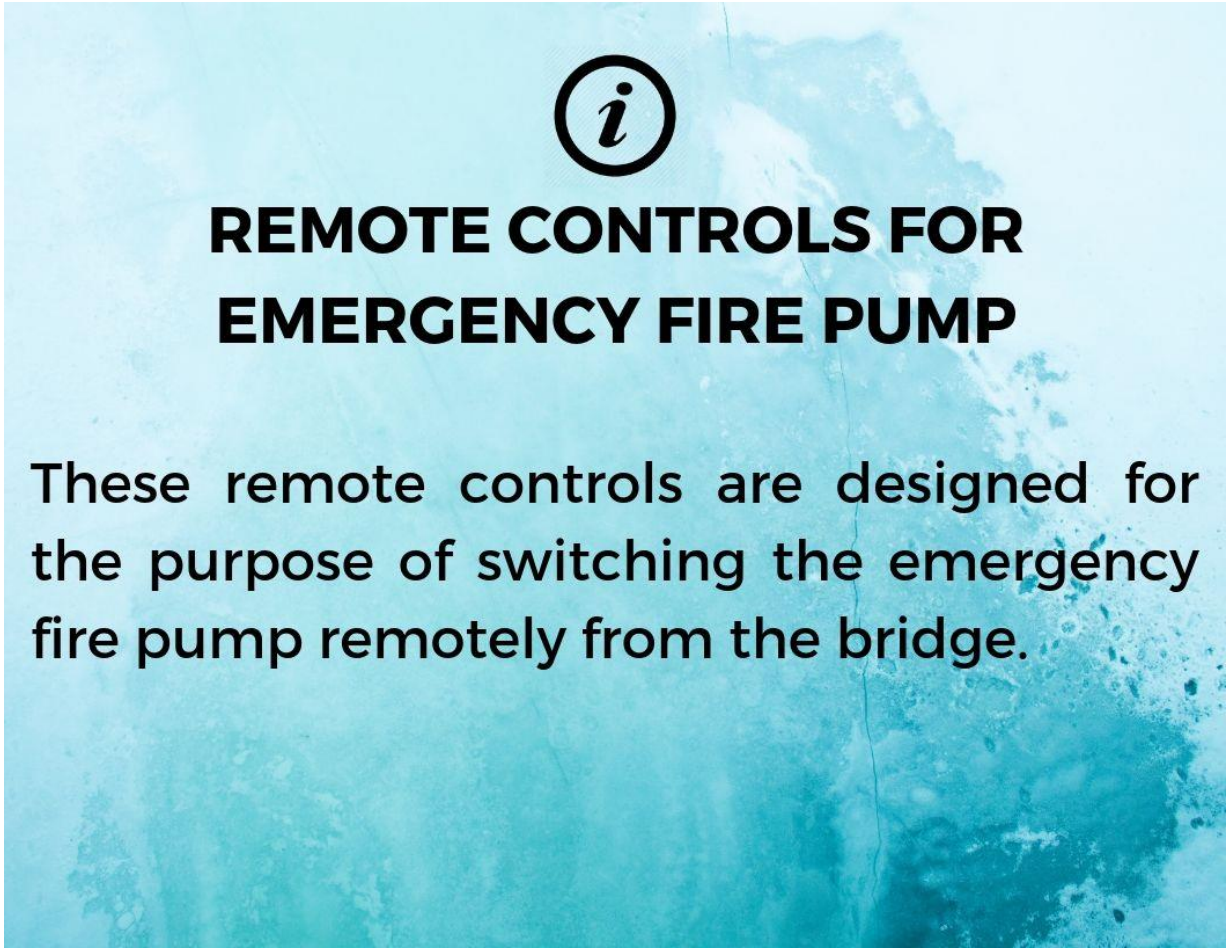

FIRE PLAN
The fire control plan provides information about fire station on each deck of the ship. It also explains the type of fire detection system and fire fighting systems available on ship.

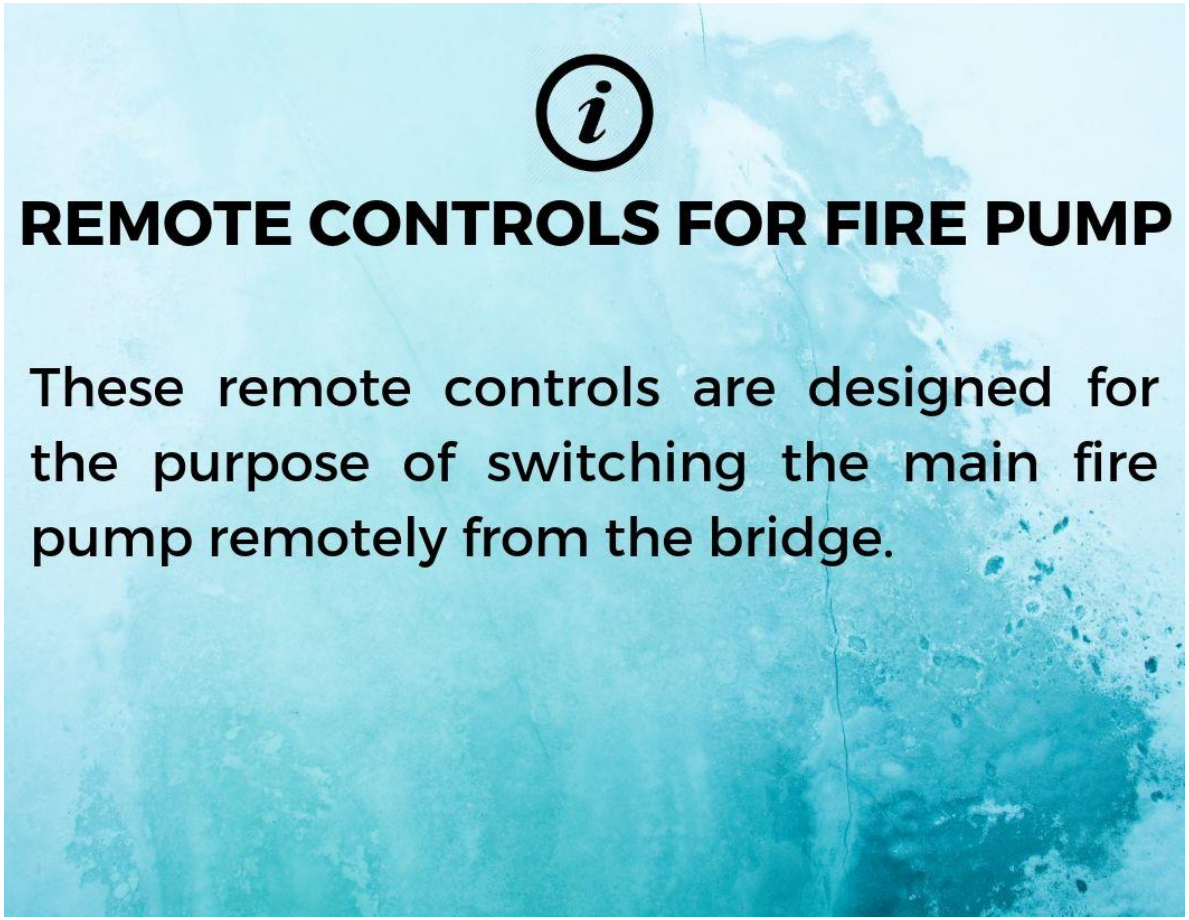

GENERAL/FIRE ALARM BELL
General alarm in a ship is sounded to make aware the crew on board that an emergency has occurred such as fire, collision, grounding, or a scenario which can lead to abandoning ship etc.

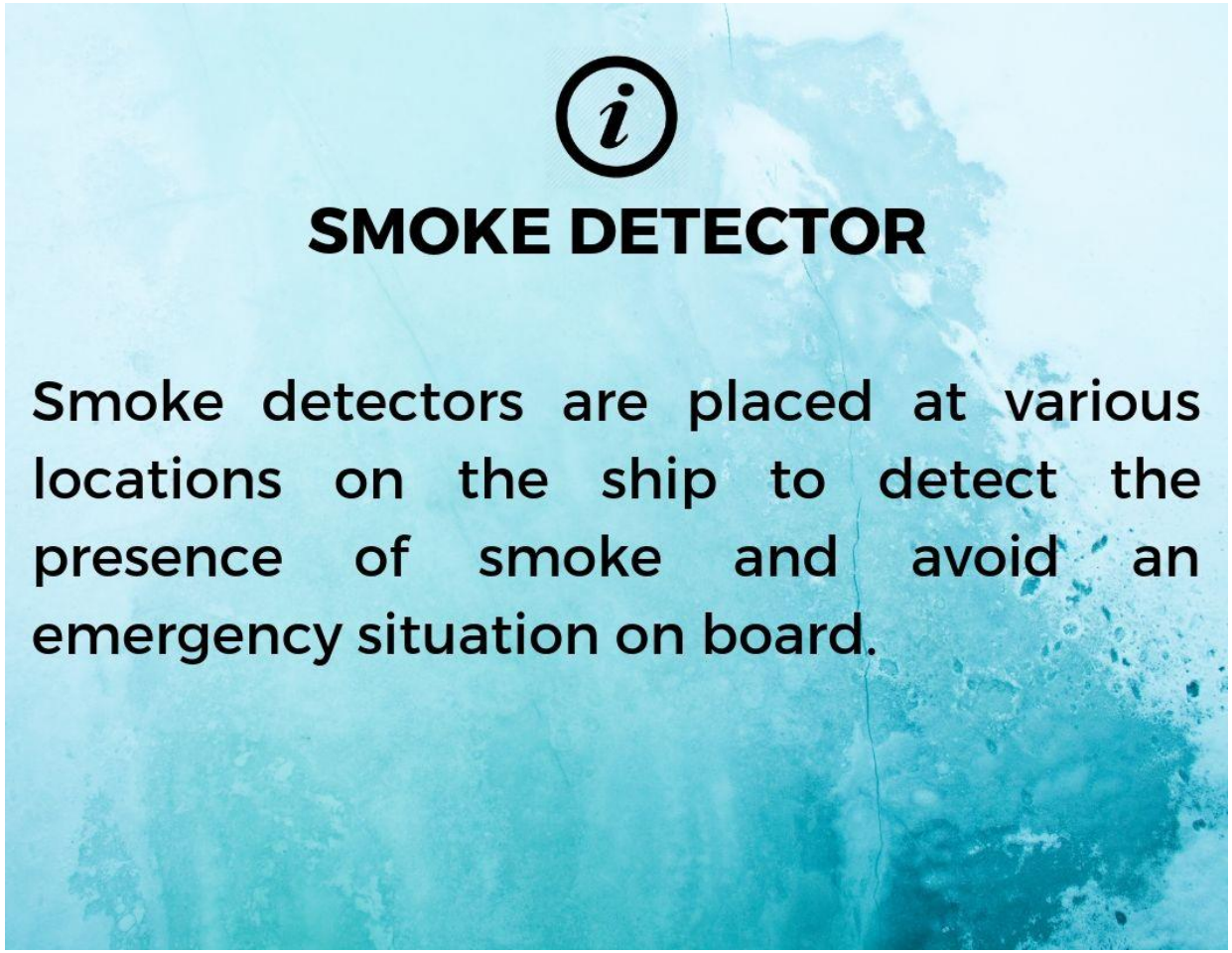

HEAT DETECTOR
A heat detector is a fire alarm device designed to respond when heat energy from a fire increases the temperature of a heat sensitive element.


MANUAL OPERATED CALL POINT
Manual alarm call points are designed for the purpose of manually triggering an alarm after a fire has occurred, by pressing the button or breaking the glass, the alarm signal can be triggered.


PUSH BUTTON FOR GENERAL ALARM
The push button is to trigger the general alarm on. General alarm in a ship is sounded to make aware the crew on board that an emergency has occurred such as collision, grounding, or a scenario which can lead to abandoning ship etc.


REMOTE CONTROLS FOR
EMERGENCY FIRE PUMP
These remote controls are designed for the purpose of switching the emergency fire pump remotely from the bridge.


REMOTE CONTROLS FOR FIRE PUMP
These remote controls are designed for the purpose of switching the main fire pump remotely from the bridge.


SMOKE DETECTOR
Smoke detectors are placed at various locations on the ship to detect the presence of smoke and avoid an emergency situation on board.

“A” DECK	
EQUIPMENT	**QUANTITY**
5 KG DRY POWDER FIRE EXTINGUISHER	2
FIRE HOSE BOX	2
FIRE HYDRANT	2
FIRE PLAN	1
GENERAL/FIRE ALARM BELL	1
MANUAL OPERATED CALL POINT	3
SMOKE DETECTOR	2

"B" DECK	
EQUIPMENT	**QUANTITY**
5 KG DRY POWDER FIRE EXTINGUISHER	2
FIRE ALARM PANEL	1
FIRE HOSE BOX	2
FIRE HYDRANT	2
FIRE PLAN	1
GENERAL/FIRE ALARM BELL	1
MANUAL OPERATED CALL POINT	2
PUSH BUTTON FOR GENERAL ALARM	1
REMOTE CONTROLS FOR EMERGENCY FIRE PUMP	1
REMOTE CONTROLS FOR FIRE PUMP	1
SMOKE DETECTOR	2

LOWER FORECASTLE DECK	
EQUIPMENT	**QUANTITY**
5 KG DRY POWDER FIRE EXTINGUISHER	4
FIRE HOSE BOX	2
FIRE HYDRANT	2
FIRE PLAN	3
GENERAL/FIRE ALARM BELL	1
MANUAL OPERATED CALL POINT	3
SMOKE DETECTOR	2

UPPER FORECASTLE DECK	
EQUIPMENT	**QUANTITY**
5 KG DRY POWDER FIRE EXTINGUISHER	2
FIRE HOSE BOX	2
FIRE HYDRANT	2
FIRE PLAN	1
GENERAL/FIRE ALARM BELL	2
MANUAL OPERATED CALL POINT	3
PUSH BUTTON FOR GENERAL ALARM	1
SMOKE DETECTOR	2

MAIN DECK	
EQUIPMENT	**QUANTITY**
5 KG DRY POWDER FIRE EXTINGUISHER	9
FIRE DAMPER	1
FIRE HOSE BOX	1
FIRE HYDRANT	1
FIRE MAIN ISOLATING VALVE	1
FIRE PLAN	1
GENERAL/FIRE ALARM BELL	5
HEAT DETECTOR	1
MANUAL OPERATED CALL POINT	3
SMOKE DETECTOR	5

AUTHOR BIOGRAPHY

The author's name is Rifqi Assidiqi, born on 3rd September 1998 in Jakarta, Indonesia. Author is the youngest child from 3 siblings. Author is derived from a family with father named Miftahul Ulum and mother named Neneng Salmia. The author was raised in several cities. The author had formal studies at SD Islam Al – Azhar 18 Cianjur (2004-2010), SMP Insan Kamil Bogor (2010-2012), and SMAN 2 Kediri (2012-2015). In 2015, the author went to Surabaya in order to continue the study at Department of Marine Engineering (Double Degree Program with Hochschule Wismar), Faculty of Marine Engineering, Institut Teknologi Sepuluh Nopember Surabaya specialized in Marine Operation and Maintenance. During the study period, the author did activities in campus organizations, e.g., Arbitrary of Robotic Competition in ITS Expo 2016, and also as a member of MOM Laboratory of Marine Engineering. The author also has work experiences in two companies as engineering student intern e.g., PT. Janata Marina Indah (2017) and PT. PJB Unit Pemeliharaan Wilayah Timur (2018). For further discussion and suggestion regarding to this research, the author can be reached through email stated as below.

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