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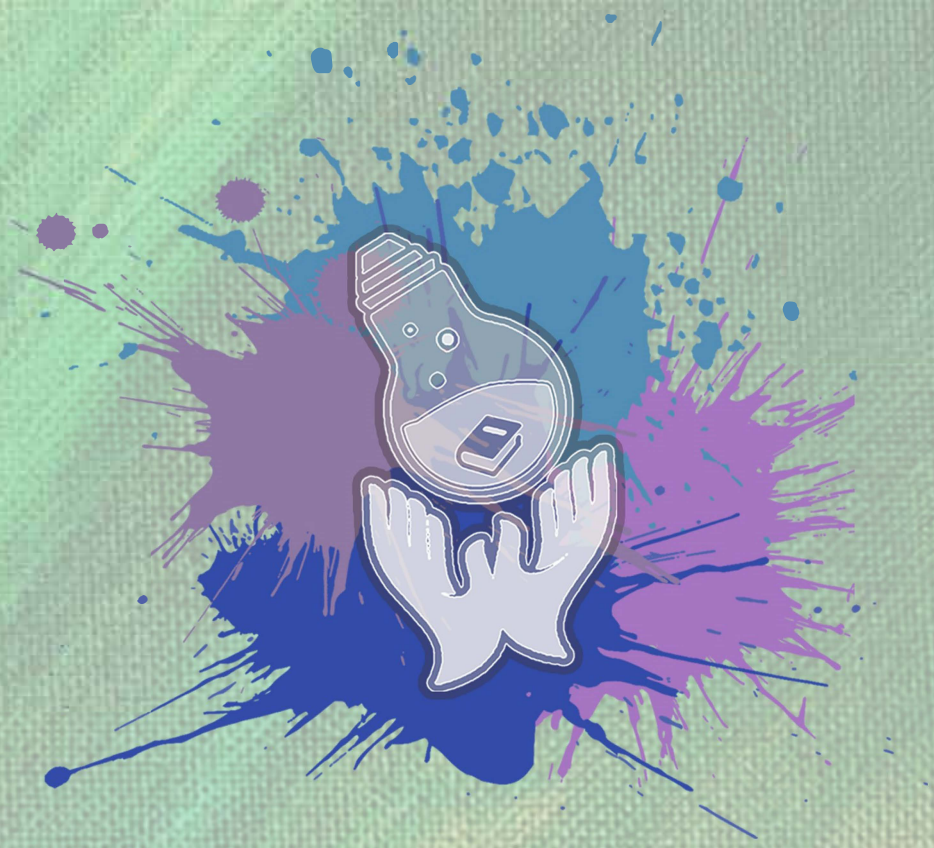

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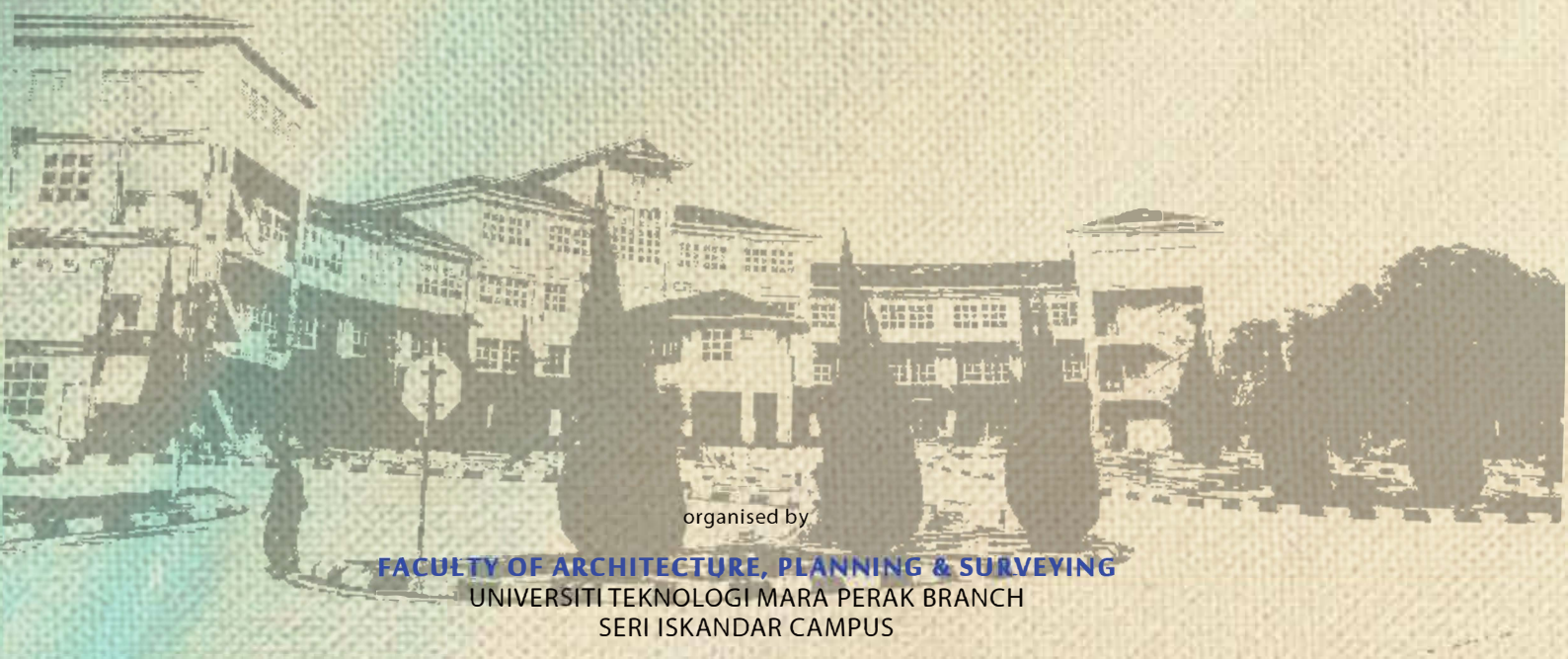

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STEEL FRAME ASSEMBLY ROBOT

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Abstract:
At present, the Industrial Revolution 4.0 emerges and changes the minds of many community on the implementation of new and sophisticated technologies, especially in the construction industry. Industrialized Building System (IBS) is one of the elements in construction that provide high technology and one example of IBS is steel frame system. However, there are few problems still happen during the process of installation steel frame system. Therefore, a study has been conducted to identify problems in the current method of installing steel frame system. Next, to determine the various methods and innovation approaches on technologies used from the past up to now and lastly, to propose an innovation idea to cater all the problems. This study was started out by doing desk study from articles, books and journals. Then, data collection also has been employed by assembling the components of innovation idea and also make simulation. Overall, this innovation idea is hoped to be accepted in the construction industry as it has a very high impact on the industry especially regarding its performance to the overall process of steel frame installation.

Keywords:
Steel frame system; Structure; Installation; Assembly; SFAR

1.0 INTRODUCTION

The construction industry in Malaysia is changing from conventional methods to a more efficient system known as Industrialised Building System (IBS) (Mydin, 2014.) IBS is simply defined as a construction technique in which the IBS components are manufactured in a controlled and well organised environment either on or off-site. It is applied in the process of constructing fast building from small building to skyscrapers. Generally, there are six types of IBS used in Malaysia and one of that is steel framing system. In this system, steel frames are transported, positioned and assembled into a structure by minimizing additional work on construction sites (Mydin, 2014.) However, there are few problems occurred during the process which are first regarding the size of current machine and second is the connection parts are still be done manually. Therefore, this innovation project will identify the problem in the current method of installing steel frame system. Then, this project will also specify the various methods and innovation approaches for technology used in the installation process from the past to the present. Finally, this project will suggest an innovation idea to overcome problems in the current method used to install steel frame systems. The innovation idea is to invent Steel Frame Assembly Robot (SFAR) for the assembling and jointing works of steel frame system.

2.0 LITERATURE REVIEW

2.1 Various Construction Innovation Approaches

2.1.1. Evolution in Lifting Machines

In the crane industry history, the first crane was born in the United States during World War I (1918). However, during that year, the truck crane capacity can only reach less than 9091 kg (10 tonnes) and the crane at that time are designed with no carrier yet. Then, at the end of World War II (1945), the cranes were being created using a kind of boom lattice. From steam, the crane has changed to gas and diesel engines as a power source for moving and working.

By 1950, there are other machines using hydraulic power came up to the world such as tower cranes, truckloads and cranes with knuckle. Nowadays, cranes are already using computers and other electronic devices which can help to increase operational control of the crane itself (American Society of Civil

Engineers, 2018.) In present, there is a company known as Tadano already designs "Robotops" which is the first ever crane that is able to walk (Tadano, 2018.) In addition, there is also technology in assembling machine which is Takenaka's Welding Robot for steelwork positioning and welding (Takenaka Corp Website, 2015.) In future, it is believed that many high technology robots will be created in the construction industry.

2.1.2 Evolution in the Method of Installing Steel Frame Structure

At present, method of installing and jointing steel elements is still using either riveted connection, bolted connection, welded connection or bolted-welded connection. All the four connections, it is definitely requiring a tool for the connection installation. For example, bolt connections require tool such as wrenches to connect bolts and nuts to steel elements.

In ancient times, people invented wrench by using wrought iron (Welch & Lamphier, 2019.) In the present days, the wrench is already made from steel. However, the arrival of Industrial Revolution (IR) introduced a more systematic approach to fastener manufacturing, allowing greater numbers of screws and bolts to be produced in shorter amounts of time. In the 2000s there already has electric drills in the form of pistol-grip which are portable and can be brought anywhere. In addition, there are also pneumatic gun created for rivets and nails that produce a faster and more systematic way of installing structural steel frames.

3.0 METHODOLOGY

3.1 Desk study

Before doing any works related to assembly and simulation, the first thing to do is carrying out desk study. For this innovation project, desk study is made by reviewing many articles, books and journals on three focused topics. Among the topics focused are related to various innovation approaches to lifting equipment, method of installing steel frame systems and various robotic applications in the construction industry. The literature review has been done by studying the timeline evolution with regard to the three topics as mentioned above and the results of this study have led to the generation idea of SFAR.

3.2 Assembly SFAR components

After the idea is generated, then the next method of data collection is to assemble each of the SFAR components. Before doing the assembly, the idea will be illustrated by the initial sketch to illustrate the first picture of SFAR's overall concept. The initial sketch will first be done manually and followed by the second sketch to be detailed using SketchUp 3D Design Software. After done sketching, the assembling process has been done by showing one by one of the components from the base until it becomes a complete robot.

3.3 Simulation

Finally, the last step is to make simulation. The simulation will focus on the movement of every SFAR components to show the full concept of the idea regarding its performance. For simulation, the steps of SFAR movement is being done using Keyframe Animation which is one of the extension warehouses downloaded from the SketchUp 3D Design Software. Then, all the movements will be compiled in one video by using Microsoft Power Point.

4.0 ANALYSIS AND FINDINGS

4.1 Evolution of robotics

In line with IR 4.0, there are several types of robotic crane being invented to the world. One of the robotic cranes is Robotops which is being introduced by a company known as Tadano. Robotops is the first four-legged dual-armed robot, which integrates the structural, hydraulic and electronic control technologies like crane. Its movable parts enable the body of the robot to move in a number of ways traditional cranes cannot. Besides, the crane's outriggers are mobile, making this robot a "walking crane". Another thing is, the images provided by three internal cameras allow the operator to remotely control the crane through a monitor. This robot crane has capacity of 100kg for both clamps it has (Tadano, 2018.)

The second robotic crane is Maeda mini crane or also known as spider crane. This robotic crane is equipped with crawlers and it can travel into confined area where bigger cranes or truck cranes cannot access. There are 3 smaller models with a body width of only 590mm to 750mm which can travel through a standard single door for indoor use. In addition, this crane can lift up to eight tonne of loads (Unic Spydercrane, 2018.)

4.2 Method of installing steel frame structure

There are two main types of structural connections: welded and bolted. There are advantages and disadvantages of both. Field-welded connections will take much longer and are more expensive than bolting, as they simply take longer to weld and also require inspections at the welds. The benefits of welded connections are a more rigid connection, and they also can join odd-shaped pieces more easily than a bolted connection. Bolted connections are cheaper and in simpler buildings, welded connections are typically not necessarily safe in some locations. There can also be a need for cut outs and penetrations in certain beams for specific equipment like lines, piping and ductwork that can impact the total erection time (AISC, 1990.)

5.0 CONCLUSION

The scope of this innovation project is addressed to the contractor; hence the significance and benefit of this project will also be directed to the contractor. The first benefit of this project is the contractor can know about the current technological level in the construction industry as described in the background of the innovation project. Then, the second benefit is that the contractors are aware of the current technologies in the installation of steel frame systems. In addition, through the inspiration and concepts of the ideas that have been described, contractors can compare the current technology they are using with this new innovation idea. Finally, the contractor may also make the final evaluation by looking at the features, specifications, performance and function of this robot for use in their organization.

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