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Simulation of Controlling Mobile Robot Using Microsoft Robotics Studio (MSRS) and .NET Framework 4.5

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***Abstract* — As the development of robot technology appears the term of humanoid robot and animaloid robot. Nowadays, robots have been used in many fields such as film industry, the aerospace industry, defense industry or war machine industry, deep sea research, space, and a natural phenomenon that is at high risk. The world of robotics now can be simulated by virtually. The presence of robots in human life is getting more and more aware of the benefits. The interaction between human and robot can be expressed in human form as the controller of the robot. This research describes how to simulate the control of mobile robots. Controlling mobile robots can be done through speech recognition or via the mouse. The system development is done using the help of programming languages Microsoft Visual Studio 2013, MSRS (Microsoft Robotics Studio), and .NET Framework 4.5. The result of control of mobile robot is able to move forward, backward, turn right, turn left, and stopped according to what is commanded either by speech recognition or by mouse. The results of the control and movement of mobile robot is shown in the form of visualization of the 3D image.**

***Keywords* — Mobile Robot, MSRS, .NET Framework, Speech Recognition, Mouse, Simulation.**

I. INTRODUCTION

Excellence in the technology of the robot cannot be denied as it has long been an icon of pride of developed countries in the world. The sophistication of the technology that is owned, the tall buildings of skyscrapers, a high level of people's welfare, modem city has not feel complete without mastery in the world of robotics.

The word "robot" is derived from old Slavic word meaning monotonous or forced labor [1]. Among the common understanding of the robot is always associated with a "living being" shaped people or animals that are made of metal and electric-powered. Meanwhile, in the broad sense of the robot means a tool that in certain boundaries can work on its own in accordance with the commands that are already provided by the designer.

At the glance, the robot technology can hardly be separated by industry, so it appears the term industrial robots and robotic manipulators [2].

The definition that are popular at the time, industrial robot is a robot hand that created for various purposes in increasing production, has the form of a stiff arm connected in series and joints that can move a spinning (rotation) or extends/retracts (translation or prismatic). In the world of mechanical manipulator has 2 parts, namely, hand and wrist.

Currently, the definition of robot industry is no longer appropriate, as the technology of mobile robot already used widely since the early l980, an assortment of robots have appeared in people's lives in a variety of shapes and sizes. There is a simple form of robot design to work on activities that are easy or repeatedly. There are also robots that are designed to "behave" very complex and to a certain extent can control himself.

The development of the world of Robotics in Indonesian developed at the beginning of the decade of 1980 [3]. At that time, the industry began to turn to the robot as a medium that can help in the process of production. Robots in the industry are indispensable for the development, the robot has been used in movies industry, space industry, defense industry, deep-sea research, space research, and a natural phenomenon that are at high risk.

The purpose of this research is to make the simulation of mobile robot by using the technology of Microsoft Visual Studio technologies of 2013, Microsoft Robotics Studio (MSRS), and .NET Framework 4.5. Identification and exploring the path that must be passed through by a mobile robot.

II. BACKGROUND KNOWLEDGE

2.1 Robots

A robot is a machine that can be controlled to work on diverse tasks without intervention from humans [4]. Elegantly the robot is accustomed be capable of see, hear, analyze their environment and can perform actions that are hard-wired. In adults, this robot is used for specific purposes and are the most widely used it is for the purposes of the industrialized world. The use of robots in the industry especially for 3D work such as Dirty, Dangerous, and Difficult.

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2.1.1 History of Robots

The word "robot" is used for the first time by playwright Karel Caspek in 1920 on the theatre perform; i.e. R.U.R (Rossum Universal Robots) which tells about machines that resemble humans, but able to work continuously without being tired. According to Fu, et al. [5], the research and first development of robot products starting from 1940 when Argonne National Laboratories in Oak Ridge, American, introduced a robotic mechanism to be named master-slave manipulator.

Commercial robot products were first introduced by Unimation Incorporated, America in the 1950s. However the intensive research in the field of Robotics and Robotics in the discipline at a time when it was not unthinkable. In the mid-1960 grow of growing automation needs. This mean robotics is starting to be accepted as a new scientific discipline that accompanies basic science and techniques that have been used previously. In countries such as the USA, Germany, and France, have sprung up the research groups that make robotic as a research theme.

Shortly thereafter in Asia were pioneered by Japan starting popping up groups of researchers in the field of robotics. In fact, the future he future of the nation's most productive in Japan develops robot technology. Simultaneously, the people of Japan are conducting research into the technology infrastructure components and other micro-robot development is the core of the modern robot [3].

The world of robotics can now be engineered virtually. Before a robot it was decided to made, it can be virtually tested beforehand either in physical form or in terms of movement. This is related to the sophistication of computers and new technology decade programming continues to be developed. The basic architecture of Robot:

- *Sensors/Input*

  Component-based instrumentation (measurement) which serves as the information about the giver as the State or position of the part manipulator.

- *Controller/Processor*

  Electronic circuit based on a microprocessor that serves as a regulator of the whole component in shaping the work function.

- *Manipulators/Actuator*

  Mechanical Parts can be enabled to move, lift, and manipulate the workpiece.

2.1.2 Classification of Robot

There are several ways to classify the robot. Some are classified according to source her energy robot such as electronic, hydraulic, pneumatic. Some are classified based on the sophistication (a simple robot that only moves in one, two, or three majors). Based on their use of the robot can be classified a personal robot, robot industry, and educational robots [6, 7].

- *Personal robot*
  A personal robot called private households because aimed at helping the work of household chores become more automated.
- *Industrial robot*
  An industrial robot used to assist in the industrial process, for example to handle material, weld, paint, and install components, etc.
- *Robot education.*
  Educational robot developed for the purpose of assisting in the process of teaching about robots

2.1.3 Human and Robots Interaction

The presence of robots in human life is to realize more and more benefits. Robotics is not only seen as the only science blossomed only in the context of technology, but the more days more and more issues related to the environment should also be taken human attention.

At the beginning of the application robot starts growing in the industry in the structure of the conditioned environment as the factory, so the more robots designed in the form of a relatively typical in accordance with the needs of the plant. With the presence of robots in the environment that are flexible such as hospitals, households, offices, forest exploration, and the development of a dangerous area, held a rearrangement of definition, construction, and function of the robot.

This situation puts the robot as part of our daily life better known with the term human-robot interactions. According to the Pitowarno, [3] and Craig, [8] interaction between humans with robots or machines can be expressed in 3 levels, namely:

- Man as robot controllers entirely the most basic interaction between man and robot is the interaction that places man as robot motion controller completely.
- Man as the manager of the operation of robots, humans act as a manager for the robot. Detailed tasks are done by robots, the overall task is being arranged by the man.

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- Humans and robots in the alignment. With the advantages and disadvantages of each will then be produced great benefits when you collaborate. In this case, people are in a position as "the man" with a wide advantage as the "expert" can be used as learning materials in making robots more human-like through clever communications

The comparison between human and robots can be referred in table 1. In the industrialized world, human-machine interaction is very important, the less dependence on human-machine the higher level of automation.

Table 1.
Comparison Human and Robot (3)

Man	Robot
Easily frazzled	Never fatigued
Less precision	Quality precision
Stable dynamic	Difficult to accommodate in the workplace dynamic created
Knowledge is global	Knowledge depends on the program
Understand the task naturally	Adaptability is very limited

2.2. Microsoft Robotics Studio (MSRS)

MSRS (Microsoft Robotics Studio) is a Windows-based programming environment that can be used for academic, hobbyist and commercial programmer for making an application to easily for the robot, can be used for the various types of hardware [9].

MSRS provides a framework that is scalable and extensible build tool for robots and applications that control it. This framework contains code libraries and tools that are needed by the developers of the robot. MSRS is built upon an environment left that facilitated the development of robots with fault-tolerant landscaping environments provide for execution of applications in a distributed system.

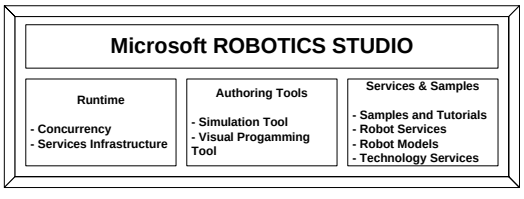

Fig. 1 Architecture of MSRS (9)

Application of architecture-based Robotics Studio is supported by a set of services provided by DSS (Decentralized System Services).

The interaction between robot nodes with the DSS facilitated by a transport mechanism based messaging. Figure 1 displayed the architecture of MSRS consists of 3 main parts:

- Runtime consists of Concurrency and Coordination Runtime (CCR) and Service Infrastructure. The CCR serves to coordinate a message without going through the manual way such as threading, lacks, or semaphores.
- Authoring Tools consists of a Simulation Tool that serves to engine simulator that is integrated into the MSRS and consists of a wide range of tools that support it.
- Services consisting of Robot services, Robot models, and Technology service. Robot services declare this type of service is used. Robot models declare the type of robots is used.

MSRS applications can not only send a simple message to communicate with external systems but much more structured because it has mechanisms that guarantee reliability and parallelism in the messaging interactions between applications and robots. MSRS is equipped with Web Services Application Protocol (WSAP) that allow the robot is controlled through the application of web services with Bluetooth. With WSAP, developers can design a robot controlled via any device, from PCS to mobile devices such as the Pocket PC.

Microsoft Robotics Studio Runtime provides a service-based architecture by combining several key aspects of the traditional web-based architecture that is part of web services that support a high flexibility and model application distribution.

The MSRS runtime environment supports designed to accommodate a set of requirements from the application robot: 1) allows to monitor a state and is associated with the individual components at the time when the application is running, 2) made an agreement with input that comes from a variety of sensors simultaneously and also from the input of orchestrator, 3) allows the overall set of robot application simultaneously both local and network traffic network, 4) at runtime makes it easy to execute with a wide range of environments, 5) expandable application interface and very easy to accommodate various kinds of hardware used.

2.3. DirectX

Microsoft DirectX is a collection of APl's for handling tasks associated to multimedia, especially game programming and video which run on Microsoft platforms.

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DirectX is a set of COM components that support for an interface which can be divided into subsets with a similar function. One of its parts is Direct3D, which competes with OpenGL and compete well with SDL. DirectX is also used among industrial production software, most markedly in the architecture areas for its ability to rapidly render high nature graphics using 3D hardware [10, 11].

The DirectX runtime and development tools software both of which are available free of charge, but it is a procedure of ownership and closed-source software. Direct X runtime was first distributed by computer game developers along with their games but later combined in the Microsoft Windows. The developers of the game often joins in the development of the newest DirectX. The final release Version of DirectX is DirectX l2, used exclusively on Windows Microsoft 10, where there is a change in the architecture of the graphics Windows.

2.4 .NET Framework

The .NET Framework is a platform for application development that contributes services to build, deploy, and run the desktop, the web, and phone applications and also provide web services [12, 13]. The Framework consists of the Common Language Runtime (CLR), which provides management for memory and other system services, and provides an extensive class library, which includes testing, reusable code for all major areas of application development. The .NET Framework also includes a large library of pre-coded solutions to common programming problems, a runtime or virtual machine which has a function to manage the execution of programs written specifically for the framework, and a set of tools to configure and build applications. This Framework also consists of three major parts: The Common Language Runtime (CLR), The Framework classes, and The ASP.NET Web. The .NET is a general purpose software development platform, which is similar to Java.

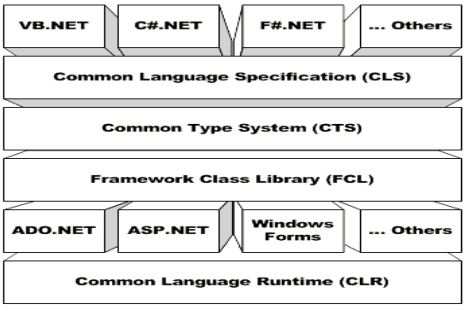

Fig. 2. NET Framework 4.5 (14)

The architecture of .NET Framework 4.5 illustrated in figure 2. Basically, .NET Framework 4 has three basic components: Common Language Runtime (CLR), which can also be called by runtime that allows to run and manage application, Base Class Libraries (BCL), it is a pre-build code to be used in application for common low-level programming task, Development Framework and Technologies, reusable technologies, customizable solutions for tailored for programming tasks.

2.5 Microsoft Visual Studio 2013 and Microsoft C#

Visual Studio can be described as a complete set of development tools to develop an ASP Web applications, XML web services, desktop applications, and mobile applications [15]. Visual Studio provides an Integrated Development Environment (IDE) for the programming language: Visual Basic, Visual C #, and Visual C++, which allows to share of tools and facilitates the creation of mixed-language solutions. Moreover, the language also uses the functionality of the .NET Framework, to provide access to key technologies that can simplify the development process of ASP Web applications and XML Web Services.

C# is an object-oriented language that is elegant and safe, which enables developers to build a variety of secure and robust applications that run on the .NET Framework [16]. C# can be used to create Windows client applications, XML Web services, a component of the distributed application, client-server applications, database applications, and much more. Visual C# 2013 provides a comprehensive code editor, convenient user interface designers for users, integrated debugger, and other tools to make it easier to develop applications based on version 4.5 of the C# language and version 4.5 of the .NET Framework.

2.6 Speech Recognition

Speech recognition (in many contexts also known as automatic speech recognition, computer speech recognition or indirectly known by the term voice recognition) is a process for converting signal words (speech) into a sequence of words or groups of words, with the help of an algorithm applied to computer programs [17].

Application of speech recognition that already appears at the end of the year about 10 years ago includes voice dialing, call routing, simple data entry. They can also act as input for processing "further linguistic" who received the request in order to understand the word, as an object that is explored.

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Voice recognition or speech recognition is the process of mutually closely related emphasis on the introduction of the identity of a person talks, as what is spoken.

Speech recognition system can be characterized by a variety of parameters. Spontaneously, with or without sound preparations, containing disfluencies, and far more difficult to recognize than reading from a voice note [18]. Some systems require a list of voice users must support voice examples used, although other systems supporting voice who is said to be independent, that is not contained in the list is needed. The introduction is usually very difficult when the collections of very large words or have the words that are almost similar.

When a sound is generated in a bunch of words, language or model grammar a mock replied to use for a combination of words. The model language that can easily be classified in accordance with the scope of the limited status, where there are words which are allowed to take the words given showed explicitly.

2.7. Simulation

The simulation is mimicked from some of the real things, the status of a change of circumstances or processes [19]. The function of simulation in the outline to show some of the key characteristics of the ability in the physical or abstract system. Simulation is used for a variety of contexts, including modeling either in natural or human systems to systems shows the function of each modeling. In the context of the other simulations include a technology to obtain maximum performance, safety engineering, testing, and education. The main part of a simulation the acquisition of a valid information source as a reference, selecting appropriate key and its capabilities.

Historically, simulation is used in a different developer environment extensively and independently, in the early 2000s the teaching in the field of Systems Theory and Cybernetics began to combine widely using computers which include entirely to equations and equations of the perception of sight. The simulation is generally divided into two, namely:

- *Physical simulation*

  Simulations that highlight the shape of the physics object that describe of a real object. The simulation is often used because it is small and inexpensive when compared to the real objects on a system.

- *Interactive simulation*

  One form of simulated physics special, always emphasizing the dependence on human factors simulation time, where the simulation of physics includes the man as operators. Computer simulation of the stresses on a real model or the situation predicted at a computer to study the extent to which the system can be made to work. By changing variables, predictions will be made in accordance with the capabilities of the system. An interesting application of computer simulations is to simulate a system by using the computer [20].

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III. System Architecture

The presence of the robot technology in people's lives is realized more and more of its benefits. Robotics is not only seen as the only science blossomed only in the context of technology, but increasingly more and more environmental issues related to human life. One of the basic interaction that places man as robot motion controller completely.

In this context, the robot does not have the ability to do himself any movement. All movements are fully controlled by humans as the operator. The movement of the robot directly can be detected visually through the eyes. Control for robot control can be manual controls or control automatic hung from the wit or skill of the operator.

Based on the background of the problem above, it can be seen that the main purpose of the system is a system which can control and control of mobile robot to move forward, move backward, turn right, turn left, and stopped. The results of control of mobile robot shown with 3D image visualization. The design of the system which made shown in the picture below:

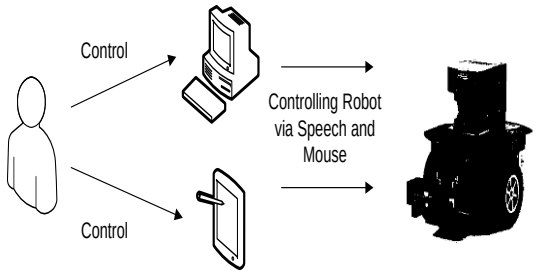

Fig. 3. System Architecture Mobile Robot Controller

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An application of mobile robot that is designed shown in figure 3 generally will consist of 2 pieces controls: 1) control via speech, controls that are used to control and control of mobile robots through voice control based on input from the user to move the word mobile robots move forward, move backward, turn right, turn left, and stopped, 2). control via mouse, controls that are used to control and control of mobile robot via the mouse to move the mobile robot move forward, move backward, turn right, turn left, and stopped. Each process, i.e. a process control through speech and process control via mouse generally have the same function but a different way of using them.

Controlling mobile robot through speech and mouse is started by running the MSRS (Microsoft Robotics Studio) and User Interface (UI) that has been created. At the time the application is run then there are 2 methods that are raised, namely the start method of the Proxy to enable Common Robotics port used as a proxy, by default the port used is 50000 and load the DSS Environments for process of DSS Environment function selecting objects and mobile robots used in the simulation there are many different types of mobile robot which can be used in 3D form, among others, Fischer Engineering Mobile Robot, lrobot (Roomba), Lego NXT Brick or Tribot, Parallax, a pioneer of Mobile Robot P3DX, Traxster and Kondo KHR-1.

3.3.1. User Interface Controlling Via Speech

This interface is used in control and control of mobile robots through voice control based on user input words of for moving mobile robot moving forward turn right, move backward, turn left, and stopped. The control interfaces design through the speech shown in figure 4.

Fig. 4. UI Controlling Via Speech

3.3.2. User Interface Controlling Via Mouse

The interface is used in control of mobile robot by using the mouse to move the mobile robot move forward, move backward, turn right, turn left, and stopped which shown in figure 5. The interface has 5 buttons, i.e. forwards button, back button, right button, the left button and the stop button.

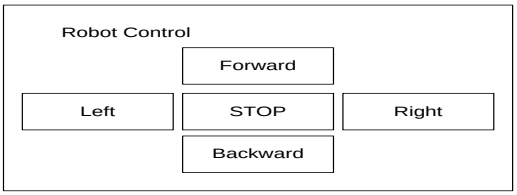

Fig. 5 UI Controlling Via Mouse

IV. MOBILE ROBOT APPLICATION

Testing of the system consists of from the tests for control via speech and control via mouse. The look of the interface has 1 form consisting of 2 group box, namely group box for voice control and group box control to the mouse can be shown in figure 6.

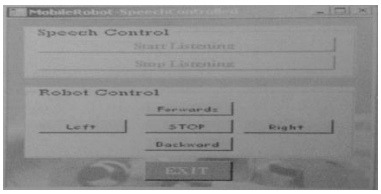

Fig. 6. UI Interface of Mobile Robot App

UI Interface in figure 6 explained mobile robot controller via speech recognition and mouse. For controlling mobile robot via speech recognition on the group box control has two buttons, namely button start listening and button stop listening. Meanwhile, on the group box control via mouse has 5 buttons mouse, i.e. forwards button, back button, right button, the button to the left, and the stop button.

4.1. Implementation Of Mobile Robot Controlled by Speech Recognition

User Interface (UI) implementation of mobile robot controlled by speech recognition application provided two buttons, namely: 1) the start button listening, is used to control mobile robots through voice recognition. The character of spoken words must be in accordance with specified word characters, 2) the stop button listening, is used to stop control of mobile robot with voice control.

There are 5 commands for controlling mobile robot by using voice control, that is moving forward, turn right, move backward, turn left and stop.

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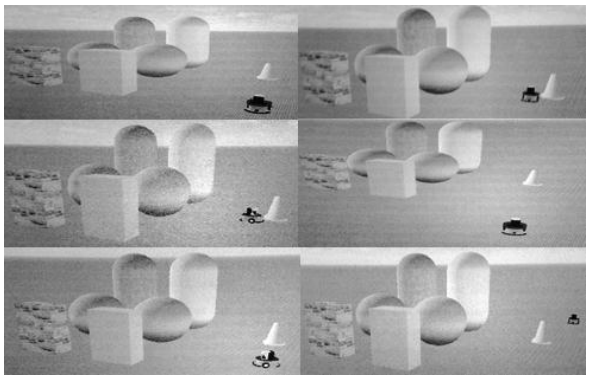

Fig. 7 (a-f). Controlling Mobile Robot via Speech

Figure 7 (a-f) shown the simulation of mobile robot using speech recognition. The picture can be described: a) the beginning position of mobile robot, b) mobile robot move forward, c) following the instruction mobile robot turn right, d) the next instruction is backward, e). the instruction of turn left show the movement of mobile robot, f).the final stop of mobile robot.

4.2. Implementation Of Mobile Robot Controlled by Mouse

Mobile robot controlling by mouse is provided by UI which has 5 command button, namely: 1) forwards button, that button is used to drive the mobile robot moving forward, 2) button right, that is the button that is used to drive mobile robot turn right, 3) back button, that button is used to move the mobile robot moving backwards to the rear, 4) button left, that is the button that is used to drive mobile robot turn left, 5) the stop button, that button is used to stop the rate of movement of mobile robots. The display of the mobile robot moving with the mouse can be shown in Figure 8.

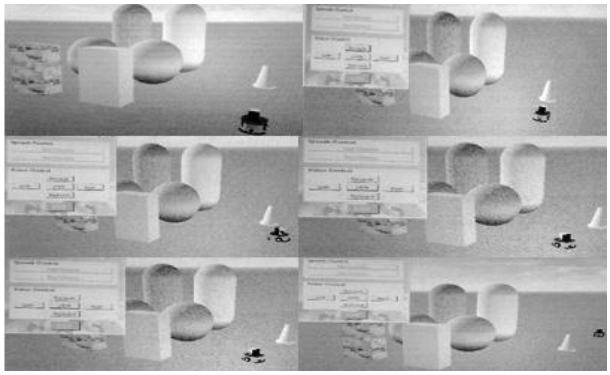

Fig. 8 (a-f). Controlling Mobile Robot via Mouse

Simulation of mobile robot using speech recognition shown in figure 8 (a-f). The picture can be described: a) the UI of the simulation engine, b) mobile robot move forward based on button press by user, c) the next button is right which made instruction of mobile robot to turn right, d) the next instruction is button backward for backward movement, e). mobile robot turn left based on mouse controller, f) the final movement of mobile robot

V. CONCLUSIONS

Based on the test results can be obtained, then the above conclusion that control and simulation of control method of mobile robot for move forward, move backward, turn right, turn left and stop either through voice or through a mouse can work as expected. Controlling mobile robot through speech easier to do than with control via mouse.

For easy integration and exploring a location for mobile robot exploration methods should preferably be added automatically without control through voice or through a mouse. For easy integration and exploring a location for mobile robot should add tools to a webcam or a laser range finder.

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