Design of Computer Programming Problem Solving System Using Artificial Intelligence-Based Chatbot

Amirhud Dalimunthe[1], Fahmy Syahputra[2], Rosma Siregar[3]

{amirhud@unimed.ac.id[1], famybd@unimed.ac.id[2], rosma.siregar@unimed.ac.id[3]}

Department of Information and Computer Technology Education, Faculty of Engineering, Universitas Negeri Medan, Indonesia[1,2,3]

Abstract. Programming training activities in writing program code are inseparable from problems related to the program source code. The problem that usually occurs is an error or bug. An error or bug is an error in the Source Code so that the program cannot be run. This study focuses on designing a problem solving system with errors and bugs in the coding. The problem solving system in resolving errors and bugs designed applies artificial intelligence-based chatbot technology. This problem solving system will be applied to the training process with a web-based training platform. The development procedure for this system follows the Agile development model stage which consists of 7 stages, namely plan, design, develop, test, deploy, review and launch. The system design with the principle of Object Oriented Analysis and Design implements the Unified Modeling Language modeling consisting of flowchat diagrams, usecase diagrams, activity diagrams and data flow diagrams

Keywords: computer programming, problem solving, artificial intelligence-based chatbot

1. Introduction

The competencies needed in the era of the industrial revolution 4.0 are the ability in three new literacies, namely data literacy, technological literacy and human literacy. Data literacy is related to the ability to read, analyze and make conclusions based on data and information (big data) obtained. Technological literacy is related to the ability to understand how machines work. Human literacy is related to the ability to communicate, collaborate, think critically, creatively and innovatively [1]. Technological Literacy is defined as the ability to use digital technology, communication tools and networks. The use of these devices in order to define, access, manage, integrate, evaluate, create and communicate information properly and legally in order to build a knowledgeable society [2].

The focus of new literacy in the industrial era 4.0 is human literacy or human resource (HR) literacy. Universities need to find new ways to develop HR cognitive capacity including higher order mental skills, critical and systematic thinking. In this era, the basic capital in HR literacy that must be possessed is skills, working in a team (teamwork), agility and cultural maturity (cultural agility) with different cultural backgrounds can still work together, and entrepreneurship [3].

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In this regard, [4] stated that the main competencies that are relevant in the future are competencies related to information technology, software, application programs, and automated systems. These competencies not only require the ability to use digital devices, applications, the web, and electronic tools, but also user-oriented skills (eg Computer Aided Design, Customer Relationship Management, and Enterprise Resource Planning). These competencies are intended to realize smart factories such as the Internet of Things (IoT) [5]. Competence in digital technology requires the ability to modify or create a technology in the field of information technology. The ability to modify to create this application requires mastery in the field of computer programming[6].

Competence in the field of computer programming cannot be separated from the mastery of programming languages and mastery in writing program codes according to the programming language used. Programming languages are standard instructions for controlling computers. This programming language is a set of syntax and semantic rules used to define computer programs. The activity of writing program codes which in the computer science environment is often also called coding will produce output in the form of program source code. In a programming training activity, coding is also inseparable from problems related to the source code. Problems that usually occur in coding activities for a program are errors or bugs. Errors or bugs are errors that usually occur in the Source Code so that the program that has been built cannot be run. These errors or bugs can be syntax errors, library errors to semantic errors or programming logic.

This research is a continuation of previous development research that has successfully developed media and information systems for computer training management with a web-based training platform. In this research, a training management system was developed that provides a new color for training participants to be able to carry out training online and practice coding using an online compiler embedded in the system.

The programming training process in coding activities carried out by training participants still has problems. The problem of errors and bugs in coding still causes confusion for training participants. This study will focus on designing a problem-solving system with errors and bugs in the coding. According to [7], problem solving is a method that teaches problem solving by emphasizing the resolution of a problem rationally. According to [8], the Problem Solving System is a media that functions to provide understanding by stimulating students to pay attention, examine and think about a problem to then analyze the problem as an effort to solve the problem. The problem solving system in solving errors and bugs that will be designed in this study applies artificial intelligence-based chatbot technology. The problem solving system that is designed will be applied to the training process with a web-based training platform.

2. Method

The development method used in this study refers to the Agile development model. Agile is a method for software development and project management [9]. The procedure for designing a computer programming problem solving system using artificial intelligence-based chatbot technology includes the following steps:

2.1 Plan

The Plan or planning stage is the stage where researchers formulate the system to be developed, the purpose of the development, how the developed system works and the benefits that can be obtained from the developed system. Researchers conducted observations and interviews with related parties to formulate problems that often occur when students practice computer programming. The results of the observations and interviews found that the problems that often occur are errors and bugs experienced by students in writing program source codes.

2.2 Design

Design is a step needed in developing a system that will be built based on data and the purpose of developing the system. This design is also the initial step before the system is built to suit the purpose of system development. The design of the AI-BasedChatbot problem solving system in this study uses the principle of Object Oriented Analysis and Design. The system design with the principle of Object Oriented Analysis and Design here implements the Unified Modeling Language modeling consisting of flowchat diagrams, usecase diagrams, activity diagrams and data flow diagrams.

2.3 Develop

At the Develop stage, the system will start to be programmed regarding the functionality and utilization of the system. This stage also includes the development of the system interface.

2.4 Test

Testing is the testing phase of the system. Testing is carried out by the research team to collect data related to the functionality of the system and how it works and to assess the validity of the system.

2.5 Deploy

Deploy is the implementation stage as well as testing on research subjects. This stage serves to collect data on direct implementation of the system to the target users of the system.

2.6 Review

Review is a discussion stage where the results of the research will be explained briefly and clearly so that they can be easily understood.

2.7 Launch

This stage aims to provide assistance and convenience to a field using a system that has been developed and also to advance the system to be better.

3. Result and Discussion

3.1. Result

Problems that often occur in computer programming are errors and bugs experienced by students in writing program source code. Errors and bugs cause confusion in finding solutions to problems caused by these errors. Based on these problems, researchers have developed a problem solving system for students to overcome these errors and bugs. The problem solving system developed by researchers is integrated with Artificial Intelligence technology to provide convenience for its users. The use of Artificial Intelligence in the form of chatbots provides an interactive environment for users as if they were communicating with experts. The specifications of the problem solving system using Artificial Intelligence-Based Chatbot are in accordance with the objectives of developing the problem solving system in this study.

The system design uses the principles of Object Oriented Analysis and Design by implementing Unified Modeling Language modeling consisting of flowchart diagrams, usecase diagrams, activity diagrams and data flow diagrams.

Flowchart is a design model to document a process flow of a system. Flowchart is a chart with certain symbols that describe the process sequence in detail and the relationship between a process (instruction) with other processes in a system [10].

The flowchart diagram of the systematic use of Artificial Intelligence-Based Chatbot in the problem solving system developed in this study can be seen in the Figure 1 below:

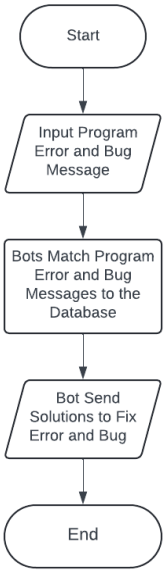

Fig. 1. Flowchart diagram of the use of Artificial Intelligence-Based Chatbot

The flowchart diagram of the dialogue in the problem solving system using Artificial Intelligence-Based Chatbot can be seen in Figure 2 below:

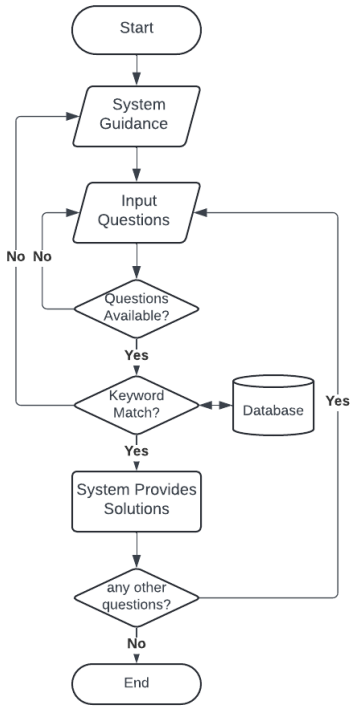

Fig. 2. Flowchart Diagram of Dialogue on Artificial Intelligence-Based Chatbot

Use case diagrams are used to find out what functions are in the system and who has the right to use those functions. Use case diagrams are modeling for the behavior of the information system to be created [11]. The actors involved in the problem solving system using Artificial Intelligence-Based Chatbot consist of admins and training participants. Design of use case diagram for admin actor can be seen in Figure 3 below:

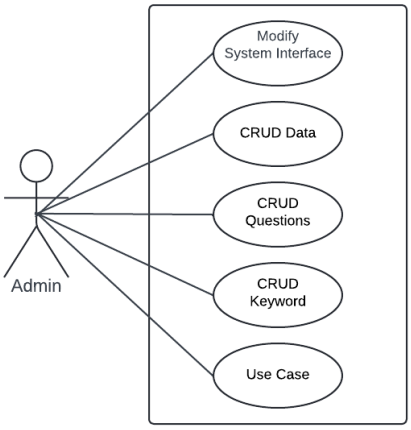

Fig. 3. Use Case Diagram of Admin

Based on the use case diagram in Figure 3 above, it can be seen that the admin can make changes or modifications to the system interface. The admin can also perform CRUD (Create, Read, Update and Delete) on data, questions and keywords. Furthermore, the admin can perform SIT (System Integration Testing) to test the effectiveness and management of the problem solving system being developed.

Design of use case diagram for training participants actor can be seen in Figure 4 below:

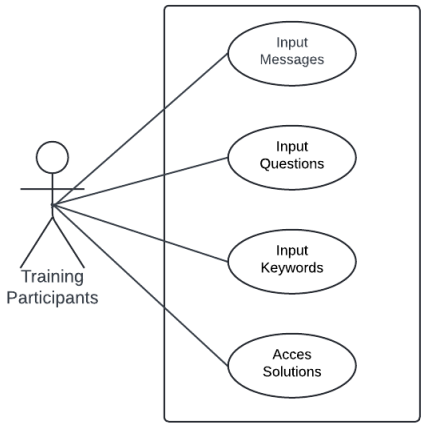

Fig. 4. Use Case Diagram of Training Participants

Based on the use case diagram in Figure 4 above, the roles that can be performed by user actors (training participants) in the developed system are to be able to input messages, input questions, input keywords to get solutions to resolve errors and bugs that occur.

The design in the form of an activity diagram is a diagram that describes a workflow or activity of a business process or menu contained in the problem solving system being developed.

The admin activity diagram for the problem solving system being developed can be seen in Figure 5 below:

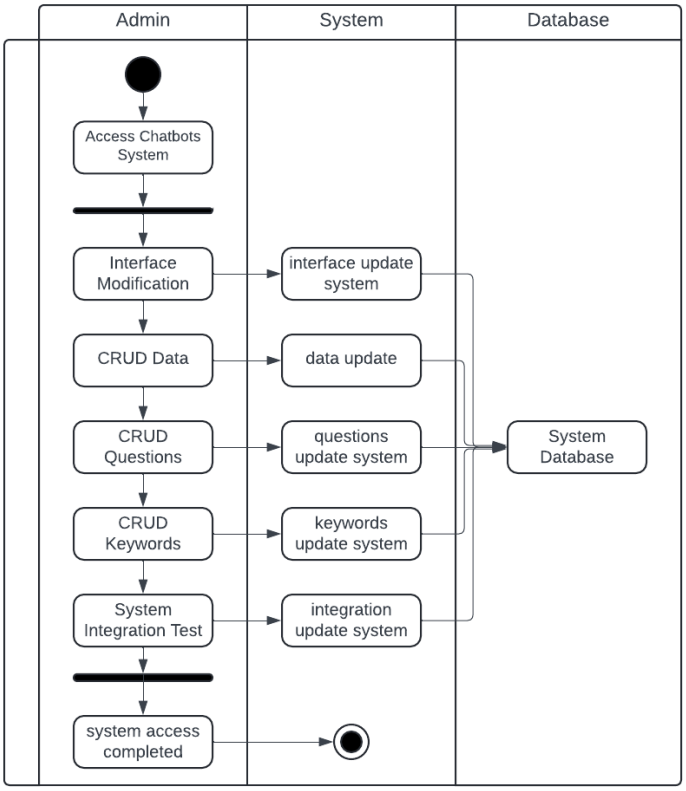

Fig. 5. Activity Diagram Admin

Based on the activity diagram in Figure 5 above, the admin can modify the interface of the problem solving system being developed. The system interface is adjusted to support the system's functionality. The admin can perform CRUD (Create, Read, Update and Delete) on several menus such as data, questions and keywords. The admin can also perform System Integration Test to update and develop the system.

The activity diagram of the training participants as users in the problem solving system using Artificial Intelligence-Based Chatbot that was developed can be seen in Figure 6 below:

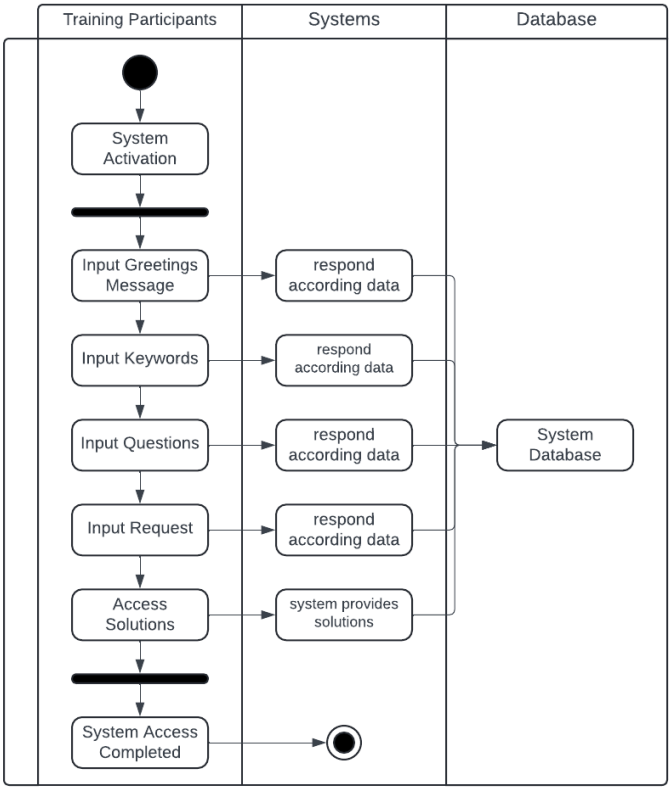

Fig. 6. Activity Diagram Training Participants

Based on the activity diagram in Figure 6 above, training participants as users can activate the system by clicking the Start button on the bot that has been provided. Training participants can input a greeting message for the system. The system will identify incoming messages according to the program being developed. Training participants can input questions for the system where the system will identify incoming questions according to the program being developed. Training participants can also input keywords to find solutions to overcome bugs and errors in a program. The system will identify incoming keywords to be adjusted to the available database.

Data Flow Diagram is a technique used to describe the flow of data in an information system [12]. The Data Flow Diagram of the problem solving system using Artificial Intelligence-Based Chatbot that was developed can be seen in Figure 7 below:

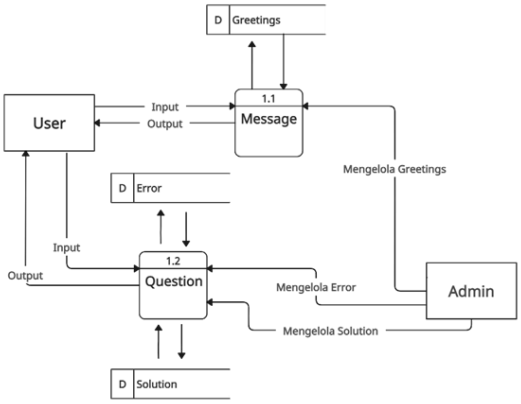

Fig. 7. Data Flow Diagram of problem solving system using Artificial Intelligence-Based Chatbot

The Data Flow Diagram shown in Figure 7 above is a form of chart or diagram used to present the data flow of a problem solving system using Artificial Intelligence-Based Chatbot which was developed.

This problem solving system uses a third-party application in its development, namely the Telegram application. Telegram was chosen as a container for the development of this system because Telegram has several advantages to maximize the development and application of the problem solving system using the Artificial Intelligence-Based Chatbot that was developed. The appearance of the AI-Based Chatbot utilizing the BotFather feature in Telegram can be seen in Figure 8 below:

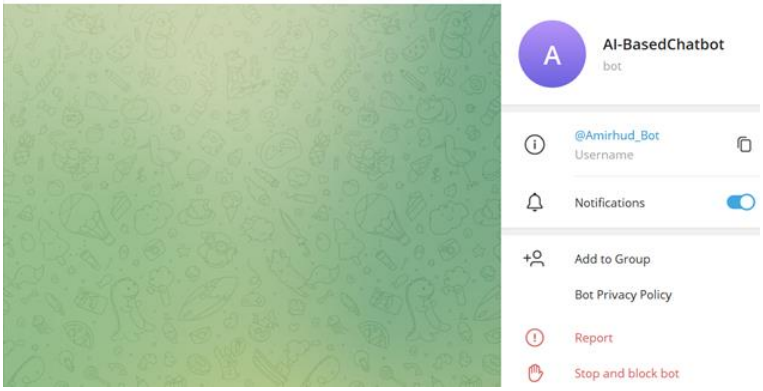

Fig. 8. Interface of The AI-Based Chatbot

The system with the AI-BasedChatbot interface shown in Figure 8 above is a system that is able to help users, especially training participants, in solving problems with errors and bugs in web programming when practicing. This problem solving system uses the form of a chatbot because chatbots have various advantages that can maximize the use of the system as a support system in solving programming problems faced by training participants.

3.2. Discussion

The development of increasingly sophisticated technology requires educators and students to continue to improve their quality. Each individual must be equipped with competencies that are in accordance with their field of study in order to compete in the era of increasingly sophisticated globalization. The quality of a student's learning process cannot be separated from the quality of the educator's teaching and supporting learning facilities. The problem solving system in computer programming uses artificial intelligence-based chatbots which are designed to help improve the intended learning process. The problem solving system is designed to help students overcome confusion in solving problems with errors and bugs in writing program source code.

The use of the Agile development model in the problem solving system design procedure provides a clear stage in this study. The Plan stage guides researchers in formulating the system to be developed, the purpose of the development, how the developed system works and the benefits that can be obtained from the developed system. Observations and interviews conducted by researchers with related parties can formulate problems that often occur when students practice computer programming. The research subjects used by researchers in this study were students in information technology and computer education at the Faculty of Engineering, State University of Medan. The problems found were errors and bugs experienced by students in information technology and computer education in writing source code programs in computer programming.

The Design stage in this study by following the Agile model is carried out after obtaining data from previous planning. This stage contains aspects needed in developing a product such as the purpose of product development, benefits obtained from the product, how the product works, product functionality to product sketches. The system design with the principle of Object Oriented Analysis and Design here implements the Unified Modeling Language modeling consisting of flowchat diagrams, usecase diagrams, activity diagrams and data flow diagrams. Design with this principle provides a clear picture for researchers in making sketches of the problem solving system to be developed.

4. Conclusion

This study has described the design of a problem solving system in computer programming using artificial intelligence-based chatbots. The design phase used refers to the design steps according to the Agile development model. After the design of the computer programming problem solving system using artificial intelligence-based chatbot is determined, the next step that is the target of the researcher is to develop the system. This stage consists of installing the required software, creating a basic bot and inputting the source code. This stage will be completed in the next research stage.

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References

[1] Aoun, J. (2017). *Higher Education on The Age of Artificial Intelligence*: MIT Press.

[2] Irfan, Mahendra. Tresno, Deny. 2018. Agile Development Methods Dalam Mengembangkan Sistem Informasi Pengajuan Kredit Berbasis Web (Studi Kasus : Bank BRI Unit Kolonel Sugiono). Jurnal Teknologi dan Open Source. Jakarta : STMIK Nusa Mandiri. Vol.1, No.2

[3] Clark, R. C., & Mayer, R. E. (2011). *E-learning and the science of instruction: Proven guidelines for consumers and designers of multimedia learning*: John Wiley & Sons.

[4] Oroma, J., Wanga, H., & Ngumbuke, F. (2012). Challenges of teaching and learning computer programming in a developing country: lessons from Tanzania. In *INTED2012 Proceedings* (pp. 3820-3826). IATED.

[5] Robins, A., Rountree, J., & Rountree, N. (2003). Learning and Teaching Programming: A Review and Discussion. Computer Science Education, 13(2), 137-172.

[6] AlZubi, M., & Wajeeh, S. (2012). Web-based learning (WBL): A model for enhancing learning environment of programming. Procedia-Social and Behavioral Sciences, 47, 1795-1799.

[7] Mathis, R. L., Jackson, J. H., & Valentine, S. R. (2015). *Human Resource Management: Essential Perspectives*: Cengage Learning.

[8] Bhat, S. K., & Raizada, S. (2018). Analysis of Online Compiler with Input and Output Interfaces for Multiple Languages. International Journal of Advanced Research in Computer Science, 9(4), 16-21.

[9] Irfan, Mahendra. Tresno, Deny. (2018). Agile Development Methods Dalam Mengembangkan Sistem Informasi Pengajuan Kredit Berbasis Web (Studi Kasus : Bank BRI Unit Kolonel Sugiono). Jurnal Teknologi dan Open Source. Jakarta : STMIK Nusa Mandiri. Vol.1, No.2

[10] Ahmed, T., Ledesma, N. R., & Devanbu, P. (2022). SYNSHINE: improved fixing of syntax errors. *IEEE Transactions on Software Engineering*, *49*(4), 2169-2181.

[11] Sáez-López, J. M., Román-González, M., & Vázquez-Cano, E. (2016). Visual programming languages integrated across the curriculum in elementary school: A two year case study using "Scratch" in five schools. *Computers & Education*, *97*, 129-141.

[12] Cedazo, R., Garcia Cena, C. E., & Al-Hadithi, B. M. (2015). A friendly online C compiler to improve programming skills based on student self-assessment. *Computer Applications in Engineering Education*, *23*(6), 887-896.