Applying Secure Programming Techniques to Protect Children from Cyber Threats

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Abstrak

Salah satu bahaya internet adalah kontennya yang melimpah, yang sangat rentan disalahgunakan oleh anak-anak tanpa pengawasan. Salah satu pendekatan untuk melindungi anak-anak dari ancaman ini adalah dengan memanfaatkan teknik peretasan yang sederhana namun efektif yang dikenal sebagai keylogger. Penelitian ini bertujuan untuk mengeksplorasi penerapan teknik keylogging sebagai alat untuk melindungi anak-anak dari risiko yang terkait dengan penggunaan internet. Metode yang digunakan dalam penelitian ini adalah Penelitian dan Pengembangan (R&D), dengan fokus pada pengembangan keylogger menggunakan bahasa pemrograman Python. Temuan penelitian menunjukkan bahwa pengembangan keylogger berbasis Python sangat layak untuk diimplementasikan dalam melindungi anak-anak dari bahaya online. Teknik ini menawarkan keuntungan dalam kesederhanaan penerapannya dan kemampuannya untuk menghindari deteksi oleh sistem operasi dan perangkat lunak antivirus. Dengan demikian, keylogger dapat berfungsi sebagai alat yang efektif untuk memantau.

Kata Kunci: *internet, keylogging, python*

Abstract

Abstract— One of the dangers of the internet is its abundant content, which is highly susceptible to being misused by children without supervision. One approach to protecting children from these threats is by utilizing a simple yet effective hacking technique known as a keylogger. This research aims to explore the application of keylogging techniques as a tool for safeguarding children from risks associated with internet usage. The method employed in this study is Research and Development (R&D), focusing on the development of a keylogger using the Python programming language. The research findings indicate that the development of a Python-based keylogger is highly feasible for implementation in protecting children from online dangers. This technique offers advantages in its simplicity of application and its ability to evade detection by operating systems and antivirus software. Thus, a keylogger can serve as an effective tool for monitoring and protecting children while they navigate the online world.

Keyword: *internet, keylogging, python*

INTRODUCTION

The internet offers numerous benefits for children, such as access to information and learning, but it also presents serious risks that cannot be overlooked. Threats like cyberbullying, inappropriate content, online predators, scams, and internet addiction can disrupt their development and mental health. Additionally, children are vulnerable to exploitation or the unauthorized sharing of personal information, which can endanger them if they are not cautious. Data on children's internet usage in Indonesia for accessing inappropriate content indicates that this phenomenon is becoming increasingly concerning (Ey & Cupit, 2011).

Children's access to age-inappropriate content, such as pornography, violence, and other adult material, has become a growing concern in the digital age. The increasing availability of digital devices and the internet has made it easier for young users to stumble upon harmful content. Many internet users under the age of 18 have reported accidentally encountering pornographic material while browsing online, highlighting the risks associated with unsupervised internet use (Gusti et al., 2019).

Research indicates that the age at which children are exposed to such content is decreasing, with exposure often beginning at a very young age. This alarming trend emphasizes the urgent need for greater awareness and proactive measures to protect children from inappropriate material. Parents, educators, and society at large must work together to create a safer online environment, fostering open conversations about digital safety and implementing effective strategies to monitor and guide children's internet usage (Permata Fitriani & Hendri Mulyana, 2023).

This is caused by various factors, including the lack of parental supervision, limited digital literacy, and the ease of accessing the internet without adequate filters. Additionally, data from the Ministry of Communication and Information indicates that hundreds of thousands of websites containing pornography or inappropriate content are blocked every year. Despite the government's efforts to restrict access to such sites, many children can still find ways to bypass filters or inadvertently encounter inappropriate content through advertisements, links shared on social media, or unsafe applications (Andrie et al., 2021).

This issue is exacerbated by the low level of digital literacy among children and adolescents, which makes them less capable of recognizing the risks or negative impacts of accessing inappropriate content (Ali et al., 2023). To address these threats, parents must actively educate their children about online safety, limit internet usage time, monitor their digital activities, and implement security software. One tool that can be effectively used is keylogging. Although keylogging is generally known as a hacking technique used to steal sensitive information such as passwords or personal data, if used correctly, this technology can help protect children in the digital world. By installing legitimate keylogger software on their children's devices, parents can monitor their online activities to detect signs of danger such as suspicious communication, cyberbullying, or access to inappropriate websites.

Enhanced keylogging with an embedded system offers more advanced capabilities for analyzing and capturing data compared to traditional keylogging methods. By utilizing AI, keyloggers can detect typing patterns, and identify passwords, or other sensitive data with higher accuracy. Previous research by Samsoni (2023) mentioned that one simple yet lethal hacking technique is keylogging. This can be dangerous if executed by someone with high social engineering skills. However, aside from being harmful, it can also be used for good, such as monitoring our surroundings to prevent unauthorized access (Samsoni et al., 2023). According to previous research by Victor Chang (2023), it was mentioned that AI enables keyloggers to learn user behavior and dynamically adjust attack techniques, such as evading detection by security software. The information obtained through keylogging can provide valuable insights into potential risks faced by the child, allowing preventive measures to be taken early (Chang et al., 2023). However, parents must use this method transparently, explain its purpose to the child, and educate them about the importance of online safety. This can be an option for parents to address the issue. In this article, we discuss how a hacking technique, namely a keylogger, can be developed using the Python language to become a monitoring tool for children using the internet.

RESEARCH METHODS

The R&D (Research and Development) methodology with the Waterfall model is a linear approach used in software development and technology product creation.(Gustiani, 2019). This model consists of several phases that must be completed sequentially, with each phase depending on the outcome of the previous one.
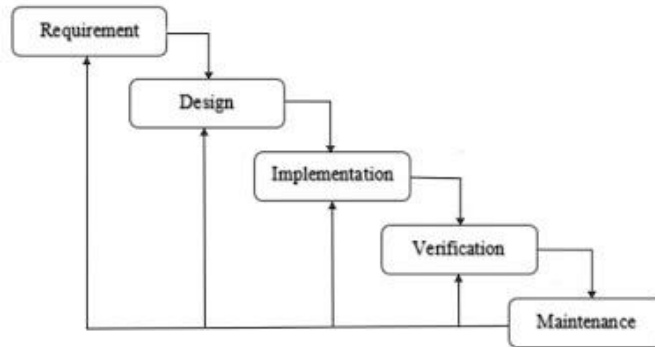

Fig 1. Waterfall Model

According to Roger S. Pressman, the Waterfall model is a classical approach in software engineering that depicts the software development process as a series of sequential stages, each of which must be completed one at a time. (Roger S. Pressman, 2005). Figure 1 shows each stage produces an output that serves as the input for the subsequent stage. One of the advantages of this method is that the work model is linear, which minimizes errors. Additionally, the structured approach provides clear direction, making this method a suitable choice for software development. However, this model also has its shortcomings. One major drawback is the inflexibility of handling changes during a project. Because the process is linear, it becomes difficult to implement significant modifications from the initial concept. As a result, if information is not documented, making changes becomes impossible. (Tjahjanto et al., 2022).

A. Requirements

The initial stage involves identifying and documenting user requirements and project objectives. Data collection is conducted using the literature review model. Data collection through literature review is a research method that involves gathering information and data from various written sources, such as books, scientific journals, articles, reports, or other documents relevant to the research topic. This method aims to establish a solid theoretical foundation and a deep understanding of the topic under investigation. (Taherdoost, 2021). In a literature review, researchers review and analyze various literature to find theories, concepts, or previous research findings that can be used as references or a conceptual framework for ongoing research.

B. Design

After the requirements are analyzed, the next step is to design the system architecture and technical specifications. The design may include user interface modeling, database structure, and system workflow. (Aleryani, 2024). Comprehensive design documentation is required to ensure that the development team can follow the established guidelines. In this activity, the system design is represented through a data flow diagram.

C. Implementation

In this phase, developers start writing code based on the created design. The written code will follow the specified requirements, and it is crucial to ensure that all functions operate according to plan. Python is a programming language widely used in web applications, software development, data science, and machine learning. (Ajay Rawat, 2020)

Python is open source so we can use it for free. We can even collaborate for its development. Most programmers agree with the statement that Python is a versatile and highly interpretive language. The syntax is very easy to learn so beginners can learn it quickly. Python can be used for website, mobile, or desktop programs. However, in the development and development process, additional framework assistance is certainly needed. Usually, Python is most often used to process things related to data.

The second software used is Visual Studio. Visual studio code commonly called VS Code is a very advanced developer tool that can be used to create programs. Its function is the same as an editor. This software is used for writing, editing, debugging, and building unified code. Apart from that, Visual Studio also includes a compiler, code completion tool, source control, extensions, and many other features for the software development process. (Wijaya & Azwir, 2020).

D. Verification

After development is completed, the software undergoes a testing phase to identify and fix bugs or errors. The testing includes white box testing and black box testing.

a. White Box Testing: Also known as glass box testing or clear box testing, this is a software testing method where the tester knows the internal structure or code of the program (Kaur, 2018). The tester uses an understanding of the code architecture to create and execute tests. White box testing focuses on evaluating the internal structure of the program, including programming logic, control paths, statements, branches, and conditions.

b. Black Box Testing: This is a software testing method where the tester does not know the internal structure or code of the program. Testing is conducted based on the functional specifications or requirements of the software. It focuses on the functionality of the software, checking whether the output produced matches the given input without examining the internal code (Khan & Khan, 2012).

E. Maintenance

After the launch, the maintenance phase is carried out to address any issues that may arise and to update the software in response to user feedback. Effective maintenance is essential to maintain the performance and relevance of the product in the long term (Pilz et al., 2023). This stage is conducted using the quick fix method. Quick Fix Maintenance: Quick fix software maintenance is an approach where changes or repairs are made quickly to resolve issues or bugs that appear in the program. Quick fixes are typically used to address urgent or critical problems that require immediate resolution, such as bugs that cause the software to malfunction or disrupt users (Hielscher & Jaeger-Erben, 2021).

RESULTS AND DISCUSSION

A. Requirements

Requirements analysis for software development is a crucial step aimed at understanding and defining the needs of users and stakeholders. The data collected is then analyzed to compile the specifications for both functional and non-functional requirements. This requirements documentation includes descriptions of functionality, technical constraints, as well as performance and security needs. The requirements analysis is conducted through a literature review.

a. A computer consists of hardware and software that interact with each other. The software provides instructions to the hardware to perform specific tasks, enabling the operation of a system. In this system, the hardware used is a desktop-based computer. The specifications required to run this system are as follows: Processor 2.27 GHz; Hard Disk 320 GB; Memory 2 GB; Monitor; Mouse; Keyboard

b. Software used in a system serves as a set of instructions provided to the hardware to facilitate interaction between the two. The software needed to build this system includes the following: Windows 8.1 Operating System; ERD Plus; Visual Paradigm; Microsoft Visio; Microsoft Word; Visual Studio Code and Python Programming.

c. To operate the system, user specifications are needed to ensure the functionality of the system can be utilized. The required user specifications are as follows: ability to operate

a computer; basic understanding of English.

d. User specifications are needed to ensure the functionality of the system can be utilized. The required user specifications are as follows: ability to operate a computer; basic understanding of English and Indonesian.

e. Overview of Keylogging. Keylogging programs are software or hardware used to record every keystroke made by a user on a keyboard. These programs operate silently in the background and are designed to monitor and capture typing activity. The recorded keystrokes are then stored in the form of logs, which may include sensitive data such as passwords, personal information, or other communications. One of the advantages of this method is that the work model is linear, which helps minimize errors. Furthermore, an operating system like Microsoft Windows will automatically quarantine any detected keylogger program that has entered the computer. This is why keylogger software that can be freely uploaded on the internet is becoming increasingly rare; one reason for this is the improvement in security systems. However, keylogger programs created in Python have a higher chance of evading security measures. This is because these programs are not standalone executable files (.exe) since they are not compiled into a new file. This is a general image of keylogging
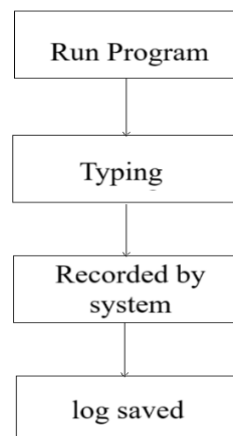
Fig 2. Overview of keylogging

Based on Figure 3, this program executes a single process, which is recording what the user types through the keyboard. This process begins with the program's execution. The user then inputs keywords via the keyboard, and Python records this activity, which is subsequently saved into a new log file.

B. Design

Based on the user's requirements and the general overview of the keylogger, the program design is developed using a Data Flow Diagram (DFD). The lowest level of this diagram is the level 0 diagram. This diagram serves to illustrate the flow of data within the

system, ensuring that the process of capturing, processing, and storing keyboard input is represented, and aligns with the intended functionalities and interactions specified by the user
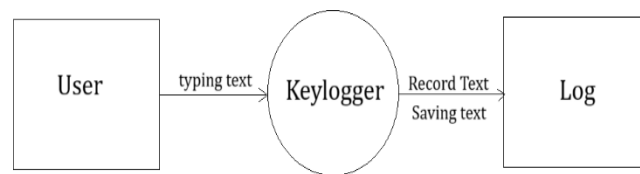

Fig 3. DFD level 0 of keylogger

Figure 3 below defines a level 0 data flow diagram or diagram context. Diagram with the lowest level because it describes things in general or in an outline. There is only one core process in this program. This is how the text input is recorded and saved to the computer. The image above describes only one entity, namely the user who entered the text. Then, the system will record and save it to a new file, namely the log. There is no DFD design for higher levels because this program consists of only one process.

C. Implementation

The implementation phase is the stage in which the designed and developed system or software is installed, configured, and deployed in the actual operational environment. The main objective of this phase is to ensure that the software can be effectively used by the users and functions according to the specified requirements.

This program uses Python as the programming language and Visual Studio as the software editor. This section consists of two parts: the program's source code listing and the test results:

a. Source code to import module.

```
from pynput
```

The above syntax is used to execute pynput. pynput is a module in Python used to handle user input in a more complex and interactive way. In this case, it is used to control and monitor input devices such as the keyboard and mouse

b. Souce code to import library

```
Import keyboard
```

Import keyboard is a command in Python used to import a library named keyboard. This library provides functions to handle keyboard input more easily and efficiently.

c. Source code to define a function

```
def keyPressed(key):
```

def: This keyword is used to define a function. It is Python's way of telling the interpreter that a new function is being created. keyPressed: This is the function name. You can choose the name according to the purpose of the function. In this case, keyPressed indicates that the function is related to a key press event. (key): This is the parameter accepted by the function. In this context, the key typically represents an object or value associated with the pressed key. When this function is called, the argument passed to the function will be accessible within the function using the parameter name key. The above syntax essentially declares a function named keyPressed that accepts a single parameter called key

d. Source code to display output

```
print(str(key))
```

print(): This is a built-in function in Python used to display output to the console. It can print various types of objects, such as strings, numbers, lists, and others. str(key): The str() function is used to convert the key object into a string. All objects in Python can be converted to a string, and this function returns the string representation of the object. In this context, key is usually an object related to a key press event (e.g., when using the pynput library to handle keyboard input). The above syntax is essentially a statement used to print (display) the string representation of the key object to the console or standard output.

e. Source code to generate a new file

```
with open("keyfile.txt", 'a') as logkey:
```

with: This keyword is used to ensure that the file being opened is automatically closed after the code block finishes executing, even if an error occurs. It is a safer and cleaner way to handle files in Python. open(): This function is used to open a file. "keyfile.txt": This is the name of the file to be opened. If the file does not exist, Python will create a new file with this name. 'a': This is the file mode. The 'a' mode stands for "append," meaning if the file already exists, new content will be added at the end of the file without erasing the existing content. as logkey: This defines a context variable logkey, which will be used to refer to the opened file within the subsequent code block. You can use logkey to read from or write to the file

f. Source code to manage exceptions

```
try:
```

This is part of the error-handling structure used to catch and manage exceptions that might occur during program execution.

g. Source code to store the character

```
char = key.char
logkey.write(char)
```

char: This is the name of the variable that will store the character value extracted from the key object. You can choose the name according to your needs, but in this context, char indicates that the variable will store a character. key: This is an object typically originating from libraries such as `pynput`, which is used for handling keyboard input. The `key` object represents the key that has been pressed by the user. Char: This is an attribute of the `key` object. If the pressed key is an alphanumeric character (such as a letter or a number), `key. char` will contain the corresponding character (e.g., if the "a" key is pressed, `key. char` will hold 'a'). However, if the pressed key is not a regular character (e.g., function keys or control keys like Shift, Ctrl, Esc, etc.), `key. char` will be `None`. This statement is used to extract the character from the `key` object.

h. Source code manage exception (following try)

```
except:
```

Used as part of the error-handling block that follows the `try` statement.

i. Source code to show error (if any)

```
print("Error getting char")
```

The above statement will print the text "Error getting char" to the console or standard output. It is a simple way to inform the user or developer that a specific issue has occurred during the execution of the program. This is the last line of the Python program list

j. Full Source code

The full source is a combination of the previous code list. This was written in the Visual Studio editor and debugged. Next, just run the command to run the program so that the keylogging program runs automatically.

```
from pynput import keyboard

def keyPressed(key):
    print(str(key))
    with open("keyfile.txt", 'a') as logkey:
        try:
            char = key.char
            logkey.write(char)
        except:
            print("Error getting char")
```

k. Testing

The Python program is executed using the Visual Studio editor. This program runs in the background, making it invisible to the user. This runs automatically by utilizing functions from Python. There is no need to make specific settings, making it very simple to operate. All input typed on the keyboard will be recorded. Activities other than keyboard input will not be captured, such as input from a mouse device. An experiment was conducted by opening a browser and typing the web address "www.uinsaid.ac.id." Subsequently, a new search query, "how to learn Python code," was entered in the browser. The result show

Fig 4. Testing with typing in the browser

Figure 4 above is the display when it is tried in the browser. The input that has just been typed will be recorded by the program. This is the result of the recording with Python.
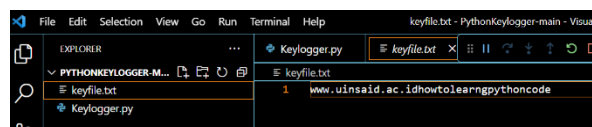

Fig 5. Recorded text

Figure 5 above is a visual studio display that shows the results of executing the Python program. As a result, the program accurately captured the keystrokes entered on the keyboard, recording them in a new log file named "keyfile.txt," which was automatically generated. The scenario is that we can install this program into the computer used by

the child. The program will run in the background so that people using the computer will not know about it. Apart from that, the Python program will not be detected by antivirus or system security on our operating system. If someone uses a computer, everything written using the keyboard will be recorded and stored in this Python program. When the user has left the computer, we can check the files generated automatically by the program. That's where we can find out what the user opened. This will be very useful for monitoring children's behavior when using the computer.

D. Verification

The verification phase of a program is a crucial process in software development aimed at ensuring that the program operates as intended and is free from errors. Testing is conducted using both white-box testing and black-box testing methodologies.

 a. White box testing

This phase is conducted by systematically verifying whether the workflow aligns with the specified requirements. The program is executed and detection is performed using image input. The processes occurring within the program are consistent with the flowchart. To carry out this testing, the examiner or tester needs to have the ability to understand the code of a program, which means that this testing cannot be perf the code will be recompiled and checked again until it achieves the expected results. This process involves white box testing, which focuses on examining the pure code of the software or application being tested, without regard to its appearance or user interface (UI)

Figure 6 above describes what happens in a program that has been executed. The process goes well until it produces a log containing the text that the user intended. The program operates as intended. Initially, it runs in the background, remaining hidden. When the user types on the keyboard, Python records the input. If there's no activity, the program enters a standby mode. Once the input is captured, it is saved in the program log, which can be accessed at any time.
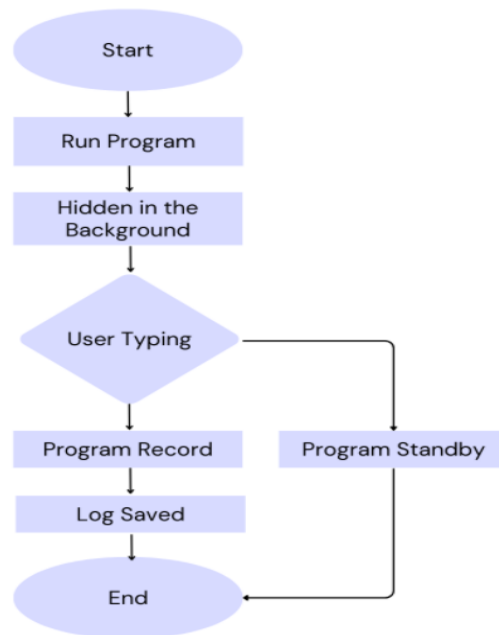
Fig 6. Flowchart

b. Black box testing

Black box testing is also commonly referred to as behavior testing. In this type of testing, the logic of the software is evaluated without delving into code analysis. The main goal is to identify functions that do not work correctly, errors in the user interface, issues with data structures, performance errors, and problems related to application initialization and termination. This method does not require direct access to or knowledge of the source code or internal structure of the application; instead, it focuses on testing from the end user's perspective.

Scenario	Expected Results	Execution Results	Conclusion
Running Program	Python programs can be executed perfectly	according to expectations	Valid
Hide Program	Python programs can be hidden perfectly	according to expectations	Valid
Record	The text entered can be recorded	according to expectations	Valid
Detection			
Saving	The program can automatically generate the text entered	according to expectations	Valid

E. Maintenance

Maintenance encompasses error correction, repair of system unit implementations, and enhancements and adjustments to the system according to requirements. Maintenance enables developers to rectify errors that were undetected in previous stages. The maintenance phase is conducted using a quick-fix model. This approach involves monitoring and modifying the program code or scripts when discrepancies are observed during the operational processes.

Table 2. Maintenance with a quick fix

Execu on	Before	After	Information
How to call the library.	Import pynput	pip install pynput	You need to install it before import.
How to generate automatically.	with open("key file.txt") as logkey:	with open("k eyfile.tx t", 'a') as logkey:	This part opens a file named "keyfile.txt" in append mode, denoted by 'a'.In append mode, any data written to the file will be added to the end, rather than overwriting the existing content. If the file "keyfile.txt" does not already exist, it will be created automatically.

CONCLUSION

In conclusion, the keylogger program developed using Python operates smoothly according to the designed workflow. This program successfully records every keystroke in real time and securely stores the resulting logs. The program flow begins with the initialization of the key press detection module, which runs continuously in the background without interrupting user activities. Once a key is pressed, the program captures the character, processes it, and saves it in a stored file. Furthermore, the program functions efficiently with minimal system resources and operates without direct detection by the user, making it an effective tool for monitoring keyboard usage.

The keylogger can serve as a means of safeguarding children while using the internet by silently monitoring their keystroke activities. By logging what is typed, parents can oversee the websites accessed, online conversations, and keywords used by their children while browsing the internet. This capability can assist parents in detecting potential dangers,

such as interactions with strangers or access to inappropriate content, allowing them to take preventive measures to protect their children from online risks. This is an illegal activity, but if it is implemented for good purposes then this could be an exception, especially for children who are still under our supervision.

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