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CodeTogether: Real-time Code Editor Application for Collaborative Programming

Shruti Thakur[1], Asst. Prof. Aastha Tripathi[2]
Department Of Computer Science Government Engineering College,Koni, Bilaspur -495006,India.

Abstract: ***The world of Internet is growing rapidly, many applications that previously created on the desktop start moving to the web. Many applicationscouldbeaccessedanytimeandanywhereeasilyusing Internet.Developersneedtoolstocreatetheirapplications, oneofthem namedcodeeditor.Thepurposeofthisresearchistodesignanddevelopareal-timecodeeditorapplicationusing websocket technologytohelpuserscollaboratewhileworkingontheproject.Thisapplicationprovidesafeaturewhereuserscancollaborateonaprojec tinreal-time.Theauthorsusinganalysismethodologywhichconductingonastudyofthecurrent code editor applications, distributing questionnaires and conducting on literature study.CodeTogether is a web application that provides workspace to writing, perform, display the results of the code through the terminal, and collaborate with other users in real-time. The application main features are providing workspace to make, execute and build the source code, real-time collaboration, chat, and build the terminal. This application supports C, C++, and Java programming languages.***
Keywords: CodeEditor,Real-time,WebSocket,Application,CollaborativeProgramming

I. INTRODUCTION

The technological development trend in software engineering has been improving, where the design of software beganmovefromthedesktoptotheweb.Nowadays,manyIDE(IntegratedDevelopmentEnvironment)applications has been made, such as Eclipse, Visual Studio, etc.[1], but IDEs which based on desktop still have significant disadvantages such as long time for configuration and installing the plug-in needed for IDE to run the project. This problem could be a huge waste of time when there are many devices that have to be configured[2].

Many software applications have been run in the cloud, and use a web browser as a user interface that allows ubiquitous access, instant collaboration, and avoid installation and configuration on desktop computers[2].

Collaborative technologies could help programmers work together while fixing bugs or discuss the program in the same single environment but in different geographical area. Therefore, it needs to make an application that can improveperformancewhilecreatingprogram suchasreal-timecollaboration,create,executeanddisplay theresult of the program using terminal.

A. Real-time Communication

Real-time Communication (RTC) is merging of communication and collaboration systems, which combined of communication technologies, like Voice-over-IP (VoIP) telephony and instant messaging, and various collaborative application[4,5]. RTC technologies consist of four interconnected building blocks; consist of unified communications, presence awareness, contextualization and E-Collaboration portfolio[6].

RTC systems usually enable two-person communication and support multi-person conference. By providing and integratingarangeofsynchronouscommunicationmediainoneintegratedenvironment,RTCsystemsallow users to collaborate in real-time, for example editing a document, voice call, multi-person video conference. RTC technology could help to solve the synchronization problem, especially when working in a team. RTC systems offer flexibility and interacting remotely with other users, also it has been facilitated and improved in terms of interaction and communication that could help construct the project more efficient.

B. StateoftheArt

State of the art of this research is to design a code editor application which has the ability to do a collaboration while working on specific file, syntax checking, run and build those source code through terminal, and users could communicate with the others using chat as media. This application provides workspace where users can create, edit, run and build source code which has been written before and some useful feature like auto complete in C, C++, and Java.

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For users who want to export the source code files to desktop or import project files from desktop could use upload and download features. Hopefully, this application could be able to help programmer to do some project collaborate in real-time with others, and increase project development performance.

II. RELATED RESEARCH

A. Real-time CollaborativeProgramming

Whileworkingondevelopmentprojects,any programmersworkingontheprojectby team.Any programmer who has the access to the project can create, change, and add code inside the same project file. So synchronization process is required between programmers to avoid code duplication, and to solve this synchronization problem integrated real-time collaboration is needed in a single environment.

The Integrated Development Environment (IDE) is focused to provide collaborative setting for programmingteams which has the ability to do real-time text editing, run and build code, chat, and various other features. The ability for editing text in real-time allows multiple users to work together while editing a document and display the changes directly to other users who has the ability to access the same document. There are a number of free applications that support real-time text editing feature, such as Google Docs. This feature not only makes excellent collaboration for common users, but can also very effective in programming.

There are also a wide variety of web-based systems that provide collaboration. For example is EtherPad thatallows real-time text editing. Ace, CodeMirror are web-based text editing component which designed to beembedded into the IDE or application[3,7].

Project or software development requires the coordination and collaboration between programmers, so that the collaboration systems are very useful to improve the efficiency in making project. The effectiveness of collaboration in programming can improve the productivity and quality of project or software[8].

Collaborative programming in real-time support programmers to work on the same programming file. Real-time system will automatically combine the code typed by a programmer without manual command from the programmer (such as update, commit)[8]. Multiple programmers enable to access and edit the same source code directory, even atthe same time.

In real-time sessions programmer can collaboratewith other programmers by joining and leaving a session ofreal-timeduring collaborativeprogramming.Therearestepsto join andleavethesession usingthejoin protocol with two-way client to receive a request from a new client who wants to join.

Toaccommodate thenewclientrequest,a distributed join-protocol wasdesignedwiththefollowingmessage:

- JOIN: newclientsend a request tothe sessionmanagerfor request to joinan existingreal-timesession.
- START: session manager send to all existing clients to inform the start join-protocol procedure to receives a request from a new client.
- READY:allexistingclientssendinformationto session manageraboutreadinessforenteringthe state.
- FINISH:sessionmanager sendinformationto allexistingclients about thecompletionofall procedures.



Fig. 1.JoinProtocol inreal-time[8]

B. Integrating CollaborativeProgram Development and Debugging within aVirtual Environment

IDEs (Integrated Development Environments) are most used tools in the activity of the programmer. To support software development and software engineering, IDE was developed in order to support collaboration in real-time, where programmers can work together to design, discuss and share in the same software development.

A collaborative integrated environment allows programmers to share programming-related tasks. One of the tools that implement collaborative IDE is ICI (Idaho Collaborative IDE)[9]. ICI allows programmers who are in different locations can collaborate in various software development activities in real-time. ICI combines technology between synchronous collaboration and a real-time debugger.

The implementation of collaborative technologies is not only used in the world of programming, but also in education. Education of computer science distance requires a more collaborative IDE integration in terms of [10]:

- Supportingreal-timecollaborationincompiling, linking,runninganddebugging sessions
- Providing a technology wheredevelopers can more easily communicate eitherby text or voice Collaborativee nvironmentenablesprogrammerstocommunicateandviewtheactivitiesofotherprogrammersin

thesameenvironment.SothatprogrammerscanchatviatextorVoIPwithotherprogrammersorotherproject teams in real-time. To work within the same development environment, programmers can invite each other to join ina collaborative IDE session, where they collaborate together in program design, coding or debugging[9].

ICI supports collaborative software development tasks. The implementation of ICI could be used in a virtual laboratory to help teaching assistants and tutors in teaching a group of students on a remote computer. Below is the flow of information in a distributed team environment ICI that shows two-way communication such as compilers or debuggers.

C. Real-TimeCollaborative Codingin aWebIDE

Now IDE is not only a tool that helps programmers in making projects or softwares, but the IDE now developed into tools that could help programmers communicate and collaborate with other programmers to make project more efficiently. One of the IDE that has been created to support real-time collaboration isCollabode.

Collabode is a collaborative web-based IDE that supports Java programming language. In Collabode when multiple users make changes, the result of the changes will be distributed to other users immediately without control requires programmers manually[7]. In addition, more than one user in the same project module can access this application simultaneously.

Collabode made in order to improve the quality of collaboration and project produced. To be able to collaborateon projects, user only need to visit the same URL where the other users are in. Collabode use EtherPad to support collaboration among multiple editors. To manage the projects, Collabode using Eclipse that provides syntax highlighting, compile errors and warnings, continuous compilation, code formatting and refactoring, and theexecution of the program code.

There are three interesting models used for close synchronous collaboration[7]:Test Driven Programming, Micro Outsourcing, and Mobile Instructor. The three models above give much different collaboration between one programmer to another programmer. Each of them has different ways such as using pair programming, side-by-side programming, and other collaborative models

III. DESIGN &METHOD

A. CodeTogetherFeatures Algorithm

CodeTogetheruse facebook plugin for login to access the application more easily and integrate with social network to collaborate each other. CodeTogether supports C, C++ and Java as programming languages that users can choose as a main programminglanguage.Userscanrunandbuildprogramtofindouttheresultsofthecodeprogram.

Userscan download the source code program along with their parentfolders that has been created. Users can do collaborationto create a project together with other user in real-time. Users can communicate with other users who exist in thesameprojectusingchatasmedia.Userscansendemailtoasksomethingorinformaboutbugspresentinthe website.

When a user successfully logs into the application, the first page displayed is the workspace page. In Figure 2 explains our algorithm that after the user logged in it will display all the projects, folders, and files that have been made (if any). Project will be displayed in the file directory on the left workspace. If a new user, then the filedirectory will appear empty.This application provides real-time connections so that any changes thathavebeen made will always be updated simultaneously. Therefore this application provide auto saving feature shown in Figure 3, if users does not perform any action on the keyboard for one minute, then the code will be saved automatically.

```
1: //javascript
2: userId←REQUEST['userId']
3: send userId with ajax
4: //php
5: function getProject(userId) // function getProject on the service
   with userId parameter
6:     load_database
7:     get project from database Project based on userId
8: end function
9: function getFolder(userId) // function getFolder on the service
   with userId parameter
10:     load_database
11:     get folder from database folder based on userId
12: end function
13: function getFile(userId) // function getFile on the service with
   userId parameter
14:     load_database
15:     get file from database file based on userId
16: end function
17: //javascript
18: if success then // if request was success
19:     view project, folder, file
20: end if
```

Fig.2.Algorithmtoview allproject,folder,andfiles

```
1: //javascript
2: initialisation flag←false
3: initialisation flagevent
4: if keyup() then // Run when button was not pressed
5:         if flagevent != undefined then
6:             clearTimeout flagevent // Clear timeout on
   flagevent
7:         end if
8:         flagevent←function setTimeout 60 // Set the time
           of timeout along 60 seconds
9:             if flag = true then
10:         code←REQUEST['code']
11:         fileId←REQUEST['fileId']
12:             send code and fileId with ajax
13:         end if
14:         flag← true
15:     end function
16: end if
17: if keydown() then // Run when button was pressed
18:         flag← false
19: end if
20: //php
21: function updateFile(fileId, code) // function updateFile which
   on the service with fileId, and code parameter
22: update code from file database with fileId based on
   parameter
23: end function
```

Fig.3.Algorithmtoautosavingcode

Run and build the program processes our algorithm shown in Figure 4. After the user create the project file and executetheprogram codetheuserwillseetheresult.Thewebsitewilldisplay theresultsin theform of aterminal. If an error occurs then the terminal will display the error that occurred.

Collaborationfeaturesareveryhelpfulinimprovingcommunicationbetweentheprogrammerandperformance in making the project[11,12]. Collaboration features our algorithm described in Figure 5, after makes a project file they can inviteotherfriends.Theownerof theprojectwillsend therequesttoanotheruserwhowantstobeinvitedto join by giving access restrictions. So that other users can do anything according to the access granted.

Figure 6 describes the algorithms to build and display terminals. Terminals can be displayed by pressing the run button or F5 on thekeyboard. When the button is pressed it will run the server NodeJS, fork terminal and theterminal will be displayed in a new tab. At the terminal can also display the error contained in the code.

```
1: //javascript
2: textarea←REQUEST['textarea']
3: fileType←REQUEST['fileType']
4: if f5 pressed then
5: send textarea, and fileType with ajax // send to function which
   on the service
6: end if
7: //php
8: function code(textarea, fileType) // function code which on
   the service with textarea, and fileType parameter
9:         file write ← textarea // create file contain
           textarea from parameter
10:        file extension← fileType // create file extension
   based on textareaType parameter
11:        compile file // compile that file with compiler
   based on their extension
12:        view outcome from file compile
13: end function
14: //javascript
15: if success then // if request was success
16:        open terminal← data // open terminal contain data
           which its has been compiled
17: end if
```

Fig.4.Algorithmtorunandbuildprogram

```
1: //javascript
2: friendId←REQUEST['friendId']
3: userId←REQUEST['userId']
4: accessRestriction←REQUEST['accessRestriction']
5: send accessRestriction, friendId, and userId with ajax
6: //php
7: function insertCollaborate(friendId, userId, accessRestriction)
   // function insertCollaborate on the service with friendId,
   userId, accessRestriction parameter
8: get in all parameters to file database
9: end function
```

Fig.5.Algorithmtocollaboration

```
1: run term.js server in nodeJS
2: fork terminal
3: run compile.sh
4: //javascript
5: build terminal
6: create new pid from term.js
7: function viewTerminal(pid)
8:         kirim pid //terminal was viewed
9: end function
```

Fig.6.Algorithmtoconstructterminal

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IV. RESULT

A. Application Architecture

User have to log in first to be able accessing theworkspace. It is shown in the Figure 7. User data will bechecked first whether it has been stored previously in the database. If the data exist then new log data will be saved into Collection logs, if not then new datawill be created in user, file, and log Collection. Furthermore, the userwillbe redirected to the workspace page; project file data will be loaded from the user Collection and file database. Facebook friends listwill be loaded after the user redirected into workspace. Thisfriend's listwill be used to addnew collaborators, and also new collaborators who have been invited will have the ability to communicate with another users via chat.

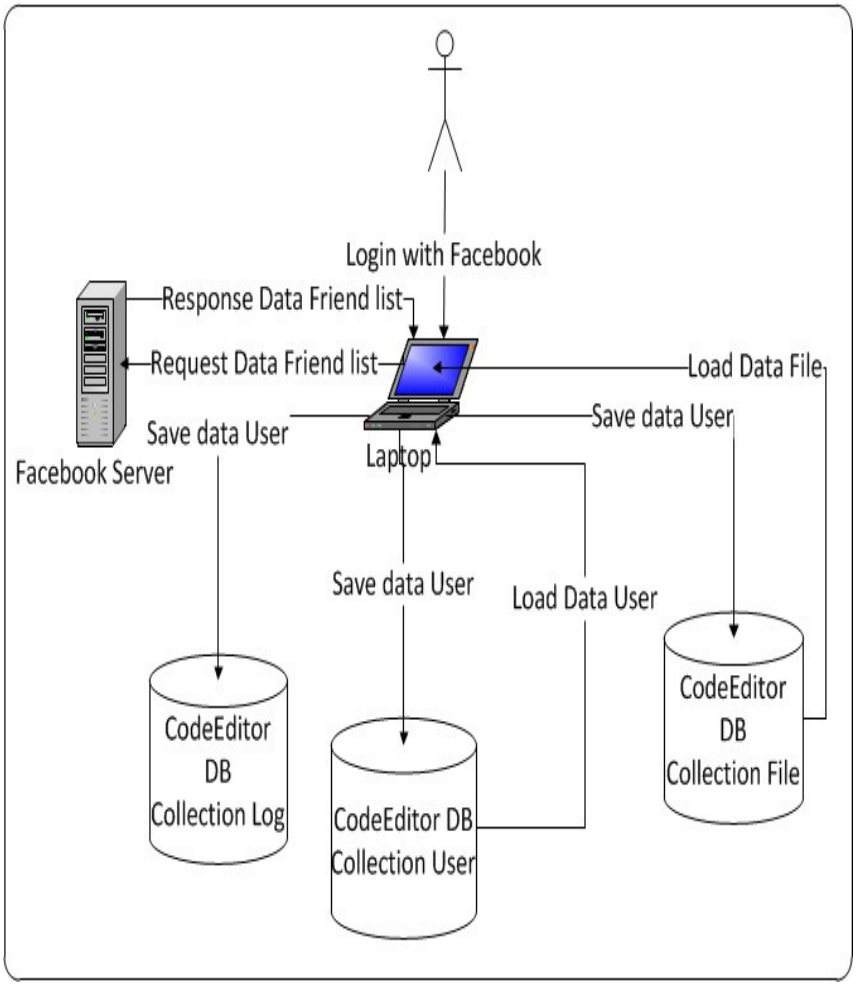


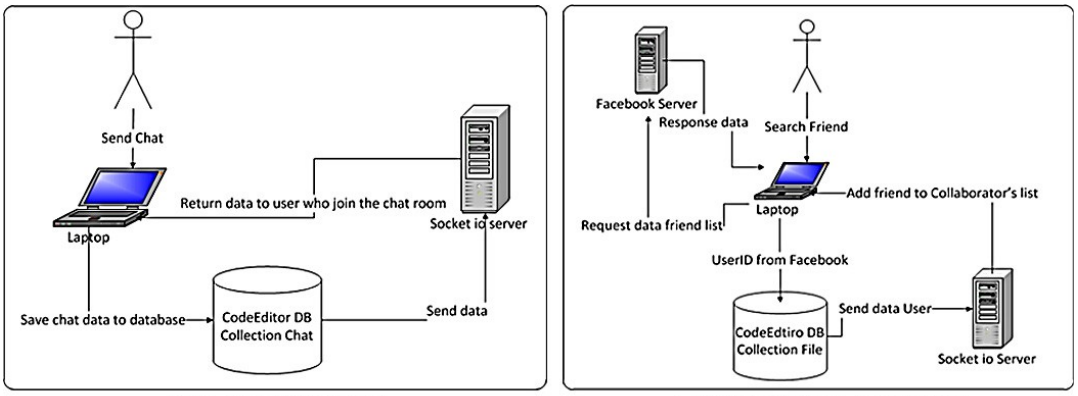
Fig.7.LoginArchitecture

Figure8illustratesthearchitecturewhenausersendsachattootherusersandaddscollaboratorto join the same file project. When the user typing a message and press the enter key, the JSON data will be sent and then the chat data is saved into the chat Collection. After that the data will be sent to socket.io server and the data is returnedtoallusers whohavebeeninvitedpreviously.Tocollaboratewithotherusers,theusercouldsearchforfriends name who are registered in Facebook using Facebook autocomplete engine to retrieve user data. After getting the user id, data will be inserted into file Collection and will be forwarded into socket.io server. Finally the collaborator will be put in the same file project

User can click the button placed at the left corner of the workspace page to access the folder sand the files in the workspace, and then the folders and the file will be displayed in the formof atree. This is shown in Figure 9. Action is provided such as create, delete, rename, move the folder or file, open, download, and upload files.

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Send chat architecture Add collaborators architecture

Fig.8.Chatandaddcollaboratorarchitecture

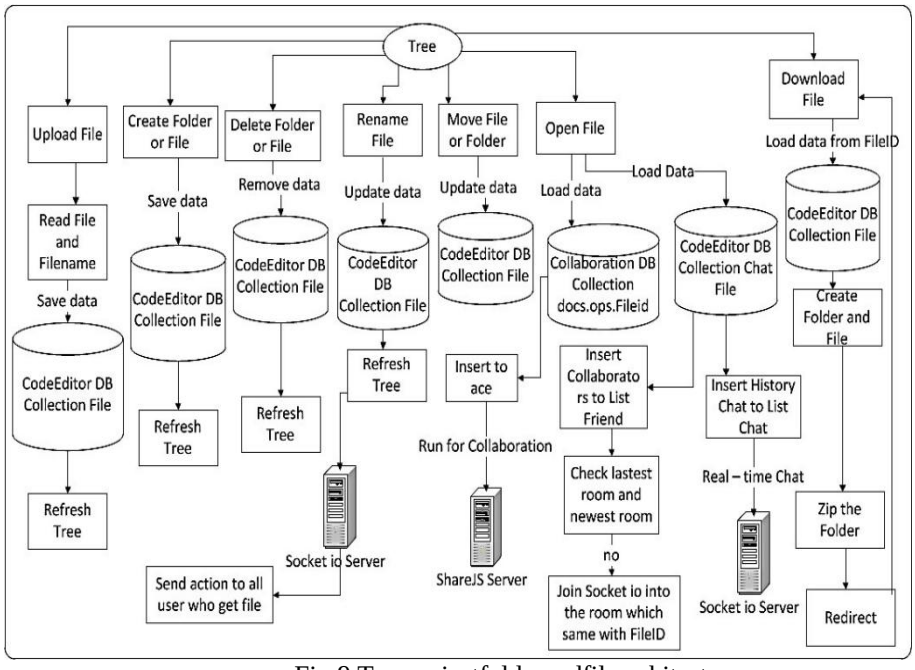


Fig.9.Treeprojectfolderandfilearchitecture

B. CollaborationFeatures

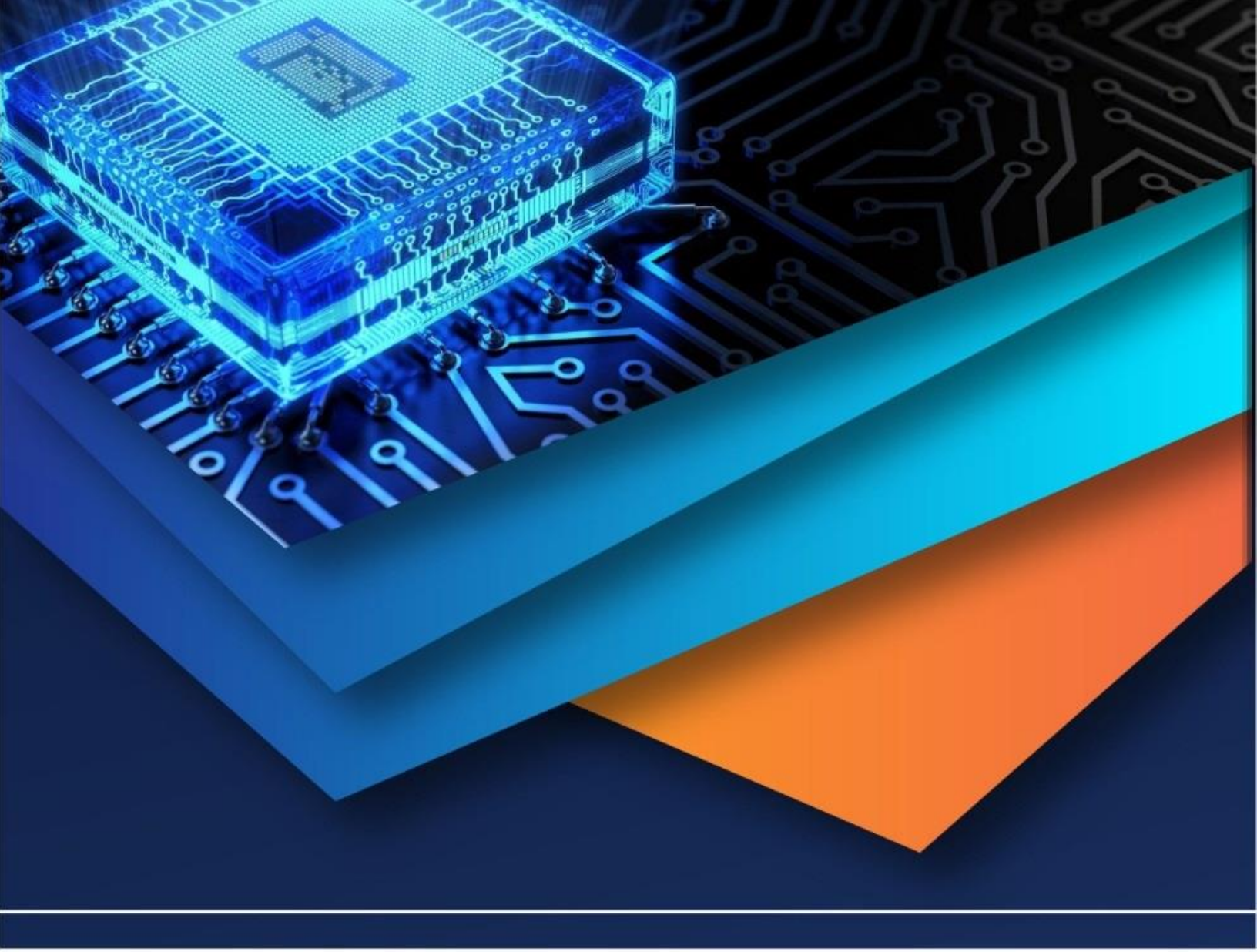
This application provides a collaboration with the user in real-time as shown in Figure 10. The user can invite other users to collaborate working on the same project through a friend list in the box on the right. After receiving an invitation to join another user in the same project, the user can communicate via chat. If a user is logged on via Facebook account, user can invite friends who are in their friend list. While login by anonymous, users will automaticallyconnects withotherusers whouse danonymousaccount.InFigure10shownthechatboxthat displays the user name, date, and there is a search feature to search friends name who would like to be invited to collaborate or communicate via chat.

V. CONCLUSION

This paper introduced our design and implementation of the real-time application for collaboration. CodeTogether is a web application that helps programmers to create and see the result of the executed source code by terminal, collaborate in real-time with other programmers by chat or invite to join the same project and manage the projectsuch as import, export, shared projects. CodeTogether supports C, C ++, and Java programming languages. CodeTogether has the mainfeatures:provideworkspacetomake,executeandbuildthesourcecode,real-time collaboration,chat, and build the terminal.

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