BILKENT UNIVERSITY
ENGINEERING FACULTY
DEPARTMENT OF COMPUTER ENGINEERING

CS 299

SUMMER TRAINING REPORT

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Performed at
İNNOVA BİLİŞİM ÇÖZÜMLERİ

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1. Introduction

I have done my summer training in Innova IT Solutions Inc. The main motivation for me to choose Innova for an internship was the huge size of the company by means of hiring more than one thousand employees and significant achievements of the company. I wanted to observe how works are executed in a big company and how people interact with each other.

I have developed a captcha control system for authentication pages which protects the system from robot logins. The company did not allow me to contribute to their codebase due to security and privacy reasons. Thus, I have developed this project as a separated library which can be integrated to all projects of the company.

In this report, first, I will reflect general information about the company and mainly the department I have trained. Then, I will explain the software systems I used throughout my project. I will clarify the specific work I have done and tell more about the significance of the work. Finally, the performance outcomes will be described under multiple topics.

2. Company Information

2.1. About the company

Innova is Turkey's one of the leading IT solutions companies with its professional staff of over 1000 people with different technologies. Since 1999, Innova has been providing platform-independent solutions to organisations in every sector, especially telecommunication, finance, production, public and

service sectors, and has succeeded in exporting solutions produced in international standards to 37 countries such as France, Germany, Uruguay, Nigeria and Turkmenistan up to 4 continents, Europe, America, Africa and Asia.

In 2007, Turk Telekom bought Innova. Istanbul and Ankara are main offices of Innova and they have 12 offices in different parts of Turkey. [1]

2.2. About the department

I was assigned in a department called Telco OSS/BSS, OSS stands for Operational Support Systems and BSS stands for Business Support Systems. It was the biggest department in the company with over 300 employees. I was part of a small group in that department with 1 supervisor and 3 software engineers. That group was working on a project for customisation of a software which was purchased from SAP. The department works for telecom operator companies. [2]

2.3. About the hardware and software systems

2.3.1. Java

Java is a general-purpose computer programming language that is concurrent, class-based, object-oriented. It is intended to let application developers "write once, run anywhere" (WORA), meaning that compiled Java code can run on all platforms that support Java without the need for recompilation. Java applications are typically compiled to bytecode that can run on any Java Virtual Machine (JVM) regardless of computer architecture and operating system. [3]

2.3.2. Java Server Faces (JSF)

It is a server side component based user interface framework. It is used to develop web applications. It provides a well-defined programming model and consists of rich API and tag libraries.

The JSF API provides components (inputText, commandButton etc) and helps to manage their states. It also provides server-side validation, data conversion, defining page navigation, provides extensibility etc. [4]

2.3.3. Apache Tomcat

Tomcat is an application server from the Apache Software Foundation that executes Java servlets and renders Web pages. [5]

2.4. About your supervisor

Name: Serkan Doğdu

Job Title: Program Manager

University: Hacettepe University

Department: Computer Science and Engineering

Year of Graduation: 1997

3. Work Done

I have developed a captcha control system for disabling robot logins to the system developed by the software engineers of the company.
Object Oriented Programming approach was used as deeply as possible. 4 Layer architecture was used for developing that project.

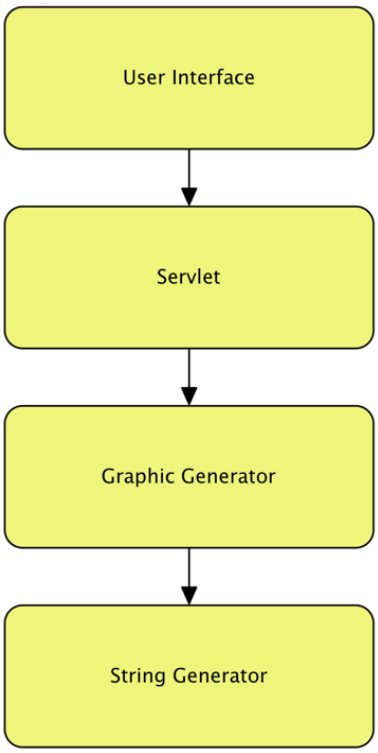

Figure 1: The block diagram of captcha generation.

The String Generator is generating a random String for displaying on graphic. I trust to the power of randomness. Thus, a character is selected randomly. Also whether a character will be a number or a letter also selected randomly. The distinction between some similar lower case and upper case should be handled by user. Since the all characters are upper case, it can be distinguishable for a person to realize the character is uppercase. If a robot tries to enter the system, it may not realize the difference so it can cause an

improvement of protection on product. *Figure 2* shows how this process is done in a function.

```java
private String generateCaptchaString(int numberOfChars) {
    Random rand = new Random();
    StringBuilder result = new StringBuilder();
    final int numBase = 49; // 0 not included (1)
    final int numCeil = 57; // 9
    final int charBase = 65;    // A
    final int charCeil = 90;    // Z

    for (int i = 0; i < numberOfChars; i++) {
        // selection for number or letter
        switch (rand.nextInt( bound: 2)) {
            case 0:
                char randChar = (char) (rand.nextInt( bound: charCeil - charBase) + charBase);
                result.append(randChar);
                break;
            case 1:
                char randNum = (char) (rand.nextInt( bound: numCeil - numBase) + numBase);
                result.append(randNum);
                break;
        }
    }
    return result.toString();
}
```

Figure 2: The captcha string generation code in Java.

The Graphic Generator makes a function call to String Generator to generate a random String to show in its graphic content. For drawing the graphic also randomness was used for putting characters. Although all of the characters are in the same order as the returned value of String Generator, every load of the page the characters tilted by changing y and x coordinates in a way that will not prevent the user from understanding it. Two examples of the generated graphics can be seen in *figure 3* and *figure 4*.

Figure 3 & Figure 4: Examples of generated graphics.

As you can see that in the same position characters are tilted different ways in *figure 3* and *figure 4*.

Servlet is mainly responsible for handling the network I/O operations. The graphic which is generated by Graphic component is received by Servlet and when the client request for the web page, the servlet upload the captcha image to the UI. The String of the image is also brought to the Servlet to compare its value with the user entered text. Two examples of the UI can be found in *figure 5* and *figure 6*.

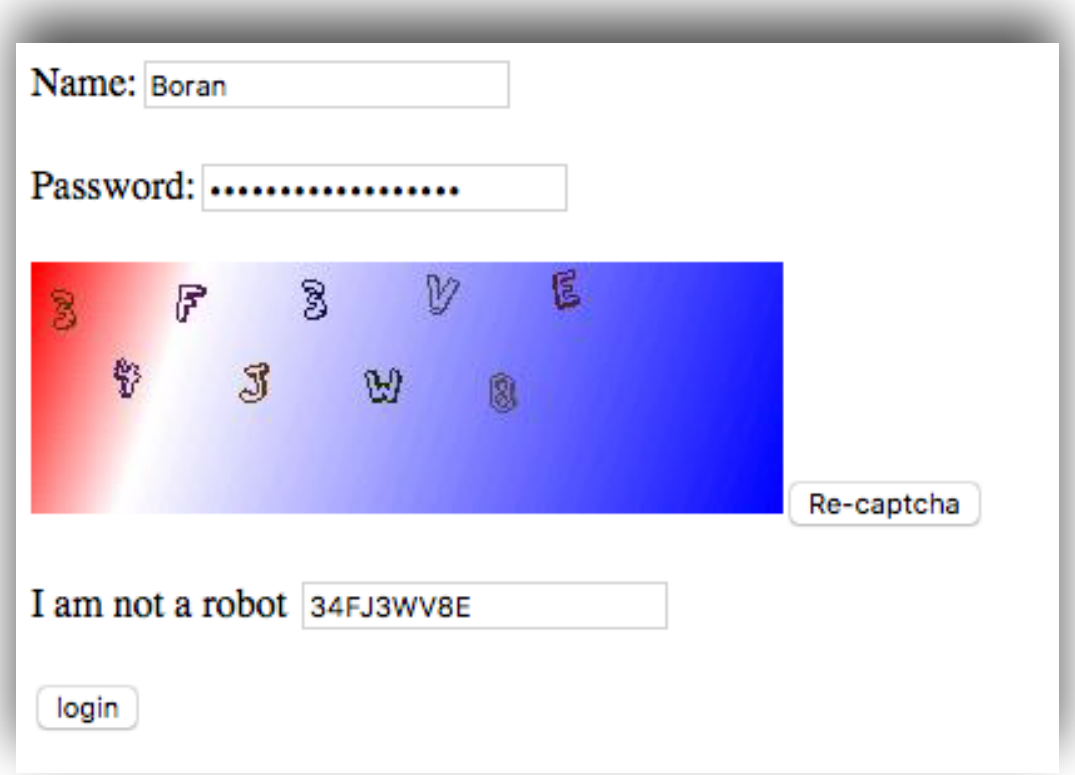

Figure 5: UI view of the application.

After Re-captcha pressed the graphic is changed and it is expected that user will enter the value of new one.

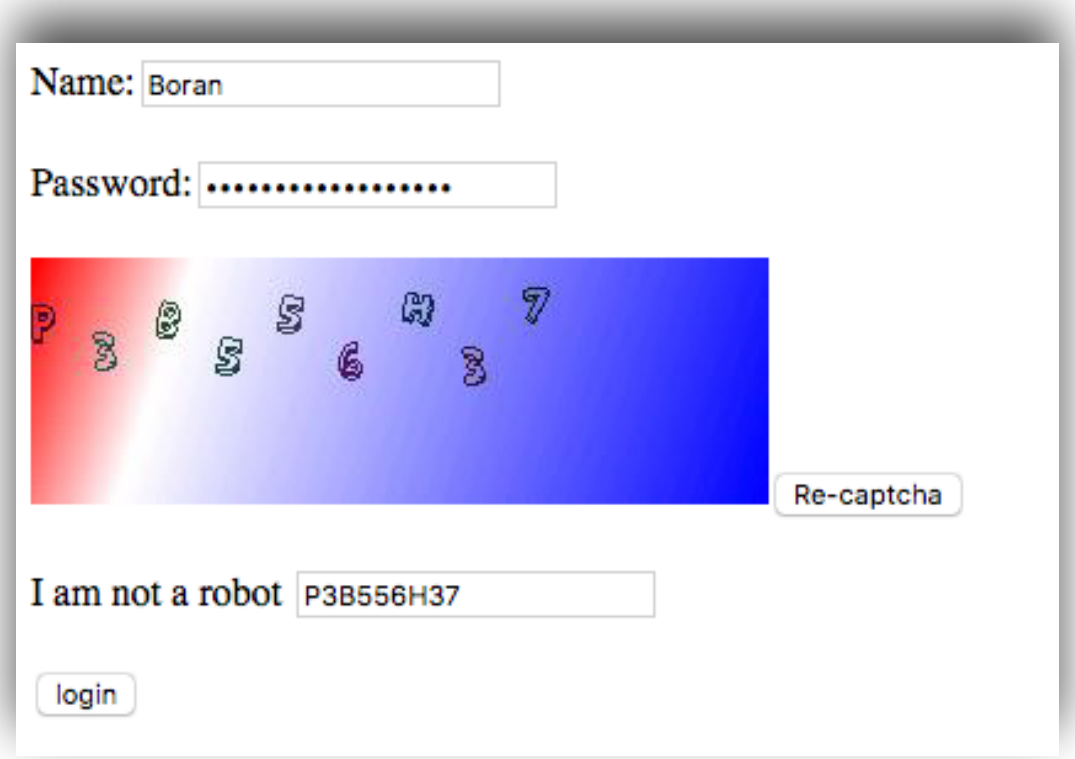

Figure 6: UI view of the application.

4. Performance and Outcomes

4.1. Applying Knowledge and Skills Learned at Bilkent

Besides all the information I gathered from my education in Bilkent, I mainly convert my theoretical knowledge on CS101 and CS102 classes to practice, in which I learned Java Programming Language. Java is the main language I used throughout the internship project. CS 319 helped me to learn Object Oriented Programming and team work deeply, I have used both of them trough the internship. Further, as Bilkent has an interactive social environment, I realised that as an engineering student, I have great communication skills comparing to other school graduates.

4.2. Solving Engineering Problems

Software Engineering requires serious research, analysis, system design, object design, implementation and testing. I began with working on which features that I need for starting on my project and determined my necessary tools which are Java Server Faces and Tomcat. Then, I read about these topics from Internet. Some mistakes that are so tiny but important wasted my time but it helped me how to act and plan against my simple but enlightening project.

The project was not difficult for me to tackle. There was not any most difficult problem for me to solve. It was far easy than course homework and projects. However, I solved a problem of non-human login to systems by the help of my engineering skills.

4.3. Team Work

Team work is an indispensable concept of the developing software world. As the projects on computer science get complicated and huge day by day, to handle a project without having a team is almost impossible or too difficult. Thus, realising the importance of team work and being in corporation with team mates are vital. My internship in Innova offered me a great experience to realise the importance of team work, that is to say my supervisor and engineers on the project I work for and I became a harmonious team. Names, universities and university departments of my teammates:

Mustafa Durmaz - Başkent University, Computer Engineering

Ahmet Erdem - Başkent University, Computer Engineering

Burak Akpınar - Başkent University, Computer Engineering

4.4. Multi-Disciplinary Work

In the project which my team works on, database are developed by this team. Frontend and backend were done by SAP and the team customises the code developed by SAP. The other teams rather than software application development which are security, information security and so on are also connected to each other and they share knowledge and skills.

4.5. Professional and Ethical Issues

Innova is a well known IT solutions provider in Turkey so that the company provides solutions to numerous different sectors. The team members that are in Telco section work with each other in full respect. Additionally, Innova shares a building with other Turk Telekom companies, Sebit and Argela . The members of the building share ideas without any misbehaviour and insult or humiliation during lunch breaks. In the Innova, every member shares his thought and ideas without hesitation.

The company uses Windows operating system PCs and some Microsoft related products. The gave an old PC to me, which was really problematic, slow and laggy. I got permission to use my own computer and I used an IDE, IntelliJ IDEA, which was free licensed by me before entering the company with my university email.

Legally work-hours are from 9AM to 6PM and 12:30PM to 13:30PM is lunch break. However, work-hours are flexible. Employees can make the lunch break more than 1 hour and sometimes they come after 9AM and leave before 6AM.

Network & Security team had a software for testing the captcha. First, they tested it for simultaneous connections and for concurrent responses. After that, by an image recognition tool they tried to enter the system with bypassing the captcha. The system prevented robot logins with the ratio of 97% in the tests.

4.6. Impact of Engineering Solutions

My project has been decided to integrate to projects are developed by the company. They even asked me to join them after the end of my Bachelor's Degree. What is more, Java is a mainly used enterprise software in the projects so using it as an expert is significant in the sector. The demonstration I made also has positive impact on my colleagues. The system affect company economically because the working of an intern is cheap and beneficial for the company. Socially it provides an opportunity for my colleagues to work on their tasks and to have more spare hours.

4.7. Locating Sources and Self-Learning

I learnt JSF and Tomcat from internet sources especially from their official documents. When I had problems, my colleagues and StackOverFlow posts was really helpful to me to learn and solve the problems. I can now quickly understand the structure of a JSF Code and organise it for my own purpose. Additionally, I can now use my experience on CS 491/492 or GE 401/402 Senior Project.

4.8. Knowledge about Contemporary Issues

While technology is rapidly evolving, malicious software has also evolved considerably. The use of Captcha keeps dangerous people away

from the system. I have produced a solution for this problem by the product.

JSF is losing popularity among backend developers. Rather than JSF, Spring MVC is gaining popularity on Java backend developing. The Spring MVC framework provides Model-View-Controller (MVC) architecture and ready components that can be used to develop flexible and loosely coupled web applications. The MVC pattern results in separating the different aspects of the application (input logic, business logic, and UI logic), while providing a loose coupling between these elements. [6] Hence applying a practice of JSF gave me a good knowledge about a contemporary issue.

There are also lots of free captcha library which are more useful and secure than my project, such as Google reCaptcha and JCaptcha. Thus, in my opinion the project I worked on does not handle contemporary technologies.

4.9. Using New Tools and Technologies

I have never used Java Server Faces and Apache Tomcat before. I learned how to use them properly and efficiently.

5. Conclusion

At the end of my summer internship, according to my team members, I am now a part of the company. The flow of events seemed to be so quick but they had a deep impact on me. I first learnt how to identify a problem. After watching lots of tutorials and reading documentations, I figured out which

software tools and environment to use. Therefore, I studied JSF on my own from the very beginning. The result was a total success. I satisfied my supervisor and team members. They told me that they realised Bilkent has a different quality to educate students and prepare them to real world problems and business. If I had not studied and passed the courses that I took in Bilkent with good grades, I would not have impressed the Innova Team this much. To sum up, this summer training opened my eyes to the real world, I have a vision about the big issues, what people think and how they behave towards situations. I saw the big pictures behind the companies and I am beginning to understand their methods to stay alive in the business. It warned me to determine my goals and start acting without wasting any time.

References

[1] “About the Company”. http://www.innova.com.tr/innova-hakkinda.asp

[Accessed: Sept 25, 2017].

[2] “About the department”. http://www.innova.com.tr/innova-ekibi-calisanlar.asp [Accessed: Sept 25, 2017].

[3] “Java”. https://www.java.com/tr/about/

[Accessed: Sept 26, 2017].

[4] ”Java Server Faces”. http://www.oracle.com/technetwork/java/javaee/javaserverfaces-139869.html [Accessed: Sept 26, 2017].

[5] “Apache Tomcat”. http://tomcat.apache.org

[Accessed: Sept 26, 2017].

[6] “Spring MVC”. https://www.tutorialspoint.com/spring/spring_web_mvc_framework.htm

[Accessed: Nov 15, 2017].

Appendices

```
@ManagedBean(name = "captchaControl", eager = true)
public class CaptchaControl {

    private String currentCaptcha;

    CaptchaControl() {
        currentCaptcha = null;
    }

    private String generateCaptchaString(int numberOfChars) {
        Random rand = new Random();
        StringBuilder result = new StringBuilder();
        final int numBase = 49; // 0 not included (1)
        final int numCeil = 57; // 9
        final int charBase = 65;    // A
        final int charCeil = 90;    // Z

        for (int i = 0; i < numberOfChars; i++) {
            // selection for number or letter
            switch (rand.nextInt(2)) {
                case 0:
                    char randChar = (char) (rand.nextInt(charCeil - charBase) + charBase);
                    result.append(randChar);
                    break;
                case 1:
                    char randNum = (char) (rand.nextInt(numCeil - numBase) + numBase);
                    result.append(randNum);
                    break;
            }
        }
        return result.toString();
    }

    String generateCaptchaString() {
        currentCaptcha = generateCaptchaString(8);
        currentCaptcha = generateCaptchaString(9);
        return currentCaptcha;
    }

    String getCaptchaText() {
        return currentCaptcha;
    }
}
```

```
@ManagedBean(name = "captchaGraphics", eager = true)
public class CaptchaGraphics {

    private CaptchaControl control;

    CaptchaGraphics() {
        control = new CaptchaControl();
    }

    BufferedImage getCaptchaImage() {
        String message = control.generateCaptchaString();
        int width = 300;
        int height = 100;
        BufferedImage img = new BufferedImage(width, height, BufferedImage.TYPE_USHORT_565_RGB);

        // random will be used for selection of color
        Random randColor = new Random();

        Graphics2D graphics = img.createGraphics();
        //graphics.setColor(Color.black);
        graphics.setFont(new Font("Action Jackson", Font.PLAIN, 20));

        FontMetrics fontMetrics = graphics.getFontMetrics();
        int stringWidth = fontMetrics.stringWidth(message);
        int stringHeight = fontMetrics.getAscent();

        Point2D start = new Point2D.Float(0, 0);
        Point2D end = new Point2D.Float(300, 100);
        float[] dist = {0.0f, 0.2f, 1.0f};
        Color[] colors = {Color.RED, Color.WHITE, Color.BLUE};
        LinearGradientPaint p =
                new LinearGradientPaint(start, end, dist, colors);
        graphics.setPaint(p);
        graphics.fill(new Rectangle(300, 100));

        int rand = randColor.nextInt(10);

        for (int i = 0; i < message.length(); i++) {
            graphics.setColor(new Color(randColor.nextInt(100), randColor.nextInt(100),
randColor.nextInt(100)));
            if (i % 2 == 0) {
                graphics.drawString(String.valueOf(message.charAt(i)), 25 * i + rand, 35 - i -
rand);
            }
            else {
                graphics.drawString(String.valueOf(message.charAt(i)), 25 * i + rand, 45 + i +
rand);
            }
        }
        graphics.dispose();

        return img;
    }

    String getCaptchaText() {
        return control.getCaptchaText();
    }
```

```
public class CaptchaServlet extends HttpServlet {

    private CaptchaGraphics graphics = new CaptchaGraphics();

    private void captchaImageRequest(HttpServletRequest request,
                                     HttpServletResponse response) throws
IOException {
        response.setContentType("image/jpg");


        OutputStream outImage = response.getOutputStream();
        ImageIO.write(graphics.getCaptchaImage(), "jpg", outImage);
        outImage.close();
    }

    private void submitCaptchaRequest(String captchaText) {
        if (captchaText.equals(graphics.getCaptchaText())) {
            // TODO go to home page after login
            System.out.println("Yes");
        }
        else {
            // TODO captcha entry is wrong
            System.out.println("noo");
        }
    }

    protected void doGet(HttpServletRequest request,
                         HttpServletResponse response) throws ServletException,
IOException {

        String username = request.getParameter("username");
        String password = request.getParameter("password");
        String captchaText = request.getParameter("captchaText");


        // TODO the condition will be controlled with database.

         if (username == null && password == null) {
             captchaImageRequest(request, response);
         }
         else {
             assert username != null;
             if ((!username.equals("") && !password.equals(""))) {
                 submitCaptchaRequest(captchaText);
             }
            else {
                captchaImageRequest(request, response);
            }
         }
    }
}
```

Self-Checklist for Your Report

Please check the items here before submitting your report. This signed checklist should be the final page of your report.

- □ Did you provide detailed information about the work you did?
- □ Is supervisor information included?
- □ Did you use the Report Template to prepare your report, so that it has a cover page, the 8 major sections and 13 subsections specified in the Table of Contents, and uses the required section names?
- □ Did you follow the style guidelines?
- □ Does you report look professionally written?
- □ Does your report include all necessary References, and proper citations to them in the body?
- □ Did you remove all explanations from the Report Template, which are marked with yellow color? Did you modify all text marked with green according to your case?

Signature: _____