Web-based Application for Monitoring of Cool-down Measurements in Graphical Format

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ABSTRACT
Graphical representation over web were required for remote monitoring of the cool-down measurements at identified locations inside a cryostat for testing mechanical components at liquid nitrogen temperatures. The temperature measurements at pre-defined locations using temperature sensors and data logger are stored in database. A front-end in Java is developed to display the cool-down measurements in graphical format over web. Study were done to resolve the Compatibility issue with reference to graph-plotting libraries in java. The graph was initially ploted using the values observed from a single sensor and storing the values in a text file. Later facility to select sensor at particular location and storing of data in Mysql database was incorporated. Monitoring of the cool-down measurements is done from remote location inside the network.

Keywords
Instrumentation, Data Acquisition, Signal and Image processing, Sensor network, Web services.

1. INTRODUCTION
An experimental setup for testing mechanical components at liquid nitrogen temperatures has been installed [1]. In this setup the temperatures at various locations for definite intervals are measured and logged over a long time span during cool-down [1]. The temperatures inside the experimental setup are measured by 14 temperature sensors (PT-100) which were placed at different locations. During this activity the temperature at each identified location is logged using a data logger. A data logger is an electronic device that records data over time or in relation to location with a sensor and is based on digital processors [2]. Graph for every sensor is plotted using the application to display the temperature-time curve. The data was imported on a computer to provide a temperature-time graph of individual sensor for comparing with results from analytical calculations.

2. PROBLEM DEFINITION
Monitoring of the cool-down temperatures was required for analysis of the process and identification of the location where the cooling is deviated from the expected values obtained by analytical calculations. It was required to compare the temperature measured in the cool-down process with the pre-calculated results from analytical calculations. The deviation in the measurements results identification of the leakage or problem with the cool-down process inside the experimental setup. A data acquisition system in VB.net was developed for monitoring this cool-down process. The measurement of temperatures streaming through the 14 sensors were monitored and consequently the graph was plotted on the computer which was connected to the logger system. However, monitoring at regular interval is required for analyzing the results and identify the leakage position. Since the cool-down process takes a much longer duration which may expand in number of days, such supervision was very time consuming and laborious task. The facility of remotely monitoring the cool-down was not available. In order to conquer former stated facility, a front end in java was developed which gave easier deployment of data to web and also constant supervision was not required.

3. LITERATURE SURVEY
For development of this web application, few tools were used which are as follows:

3.1 Eclipse
A Java IDE (Integrated Development Environment) is a software application which enables users to more easily write and debug Java programs [10]. Eclipse is a Free and Open Source IDE, plus a developer tool framework that can be extended for a particular development need [10]. Eclipse gives a standard way of developing code in the Java world, with a big success so far [10]. Eclipse IDE Mars version along with JDK 1.8 was used to create this application in java.

3.2 Java
Java is a general purpose computer programming language that is concurrent, class-based, object oriented [3] and specifically designed to have as few implementation dependencies as possible. It is intended to let application developers “write once, run anywhere” [4], meaning that compiled java code can run on all platforms that support java without the need of recompilation [5]. Java`s cross platform capabilities and security factor aids to new features to the front end developed in java and allows the deployment of data to web so the temperature-timse curves could be monitored from a remote location and the strenuous task of continuous supervision for a long duration was eliminated.

3.3 JFreeChart
JFreeChart is a free java chart library which supports pie charts (2D and 3D), bar charts (horizontal and vertical, regular and stacked), line charts, time series charts, combined plots and more. It comes with well documented APIs, which make it quite easy to understand also allowing extensive customization of charts[8]. Using JFreeChart library a line chart in java was established for temperature time curve. A line chart or line graph displays information as a series of data points connected by straight line segments. Line Chart shows how the data changes at equal time frequency [7][8]. Using JFreeChart we can create line chart in AWT as well as we can

save the graph as an JPEG image. JFreeChart version 1.0.19 was used to generate the line charts in Ecilpse IDE.

3.4 Mysql

My SQL is an open source relational database management system. SQL stands for structured query language. A standardized JDBC connector was used to enact the connection between Java IDE Ecilpse and MySql database.

3.5 Logger

Temperature sensors (PT-100) with 4 wire measurement provision were installed at defined locations on thermal shield. Electrical feedthroughs were used to bring sensor connections out of the experimental setup. HIOKI made LR8400 data logger is used to interface the sensors with the computer [6].

4. DEVELOPMENT

An experimental setup for testing mechanical components at liquid nitrogen temperatures has been installed. A data acquisition system was developed to record, visualize and analyze temperature at different locations inside the experimental setup. The temperature trend at fourteen pre-defined locations inside the setup was recorded. Continuous monitoring during the cool-down process was not possible as it runs for longer duration and remote monitoring facility was not available.

The real-time temperature data is being acquired at user set interval, and superimposed on the pre-calculated results from analytical calculations at the same location on the screen for comparison. Few experimental trials related to cool down performance of thermal shield have been performed. To overcome from the problem of monitoring from remote location, a Java based web application was developed using Ecilpse IDE Mars, Java, JFreeChart and Mysql. Open source tools like JFreeChart and Mysql were used in development of this application, which has its own additional benefits[11].

Initially the time and corresponding temperature acquired during the cool-down process was stored in a text file after logging. The application for graphical representation of cool-down measurement is developed in java using JFreeChart library tools. The development was started using JDK (Java Development Kit) 1.5 along with JFreeChart 1.0.18. During execution of the application, a lot of library exceptions occurred which concluded to incompatibility of the version of JDK and JFreeChart library. Later, a new version for both JDK (JDK 1.8) and JFreeChart (1.0.19) was used as library in Ecilpse IDE. The java application was successfully executed for cool-down process measurement and the line chart of temperature against time was plotted. The data available from logger was stored in a text file and later the application software plots the graph for the values from the file. It was further enhanced with storing the data in Mysql database for future enhancements and report generation. The required JDBC driver was added in the Ecilpse library to include the feature of utilization of Mysql database instead of reading the data from a text file. The 14 temperature sensors placed inside the experimental setup at different locations record the temperature at each interval and pass the values to the data logger. The data was stored in Mysql database either using USB port or Ethernet port. The developed java application read the data from the Mysql database and plot the graph. The database is updated at regular time intervals. The facility to store the graph in JPEG image format was also provided to the user. The application also provide display of the resulting plot of the line chart on the AWT window instead of saving it as a JPEG image file. The application was executed with the real time logger data and cool-down measurement graph was obtained successfully on web at remote location from the experimental setup.

The graph were plot using JFreeChart library. User has the facility to zoom-in, zoom-out and print the graph. Also the facility to change the axis length and saving the graph in desired image format was provided to the user.

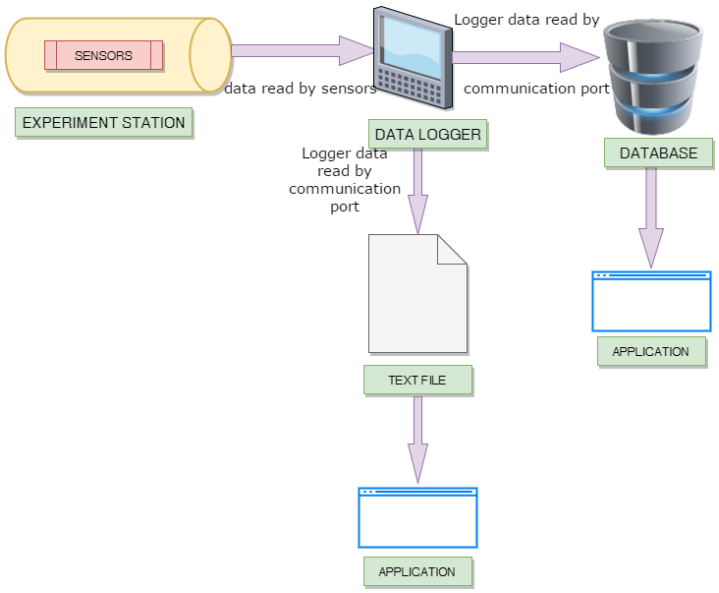

Fig 1: Flow of Data during the cool-down process

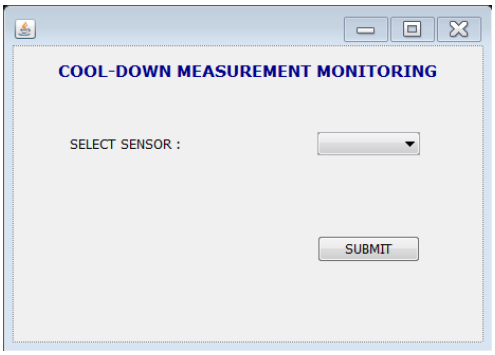

Fig 2: Selecting Sensor for Graph Display

The results from analytical calculations at the pre-defined locations are compared with the observed data and variation was recorded. The system provide facility to graphically visualize the data of selected location on web for remote monitoring. Any temperature variation gives useful feedback for modifying experimental setup or making corrections in the assumptions made for the pre-calculations. The presented work aims to describe the remote monitoring of the cool-down process on web and comparison of the observed values with the results from analytical calculations.

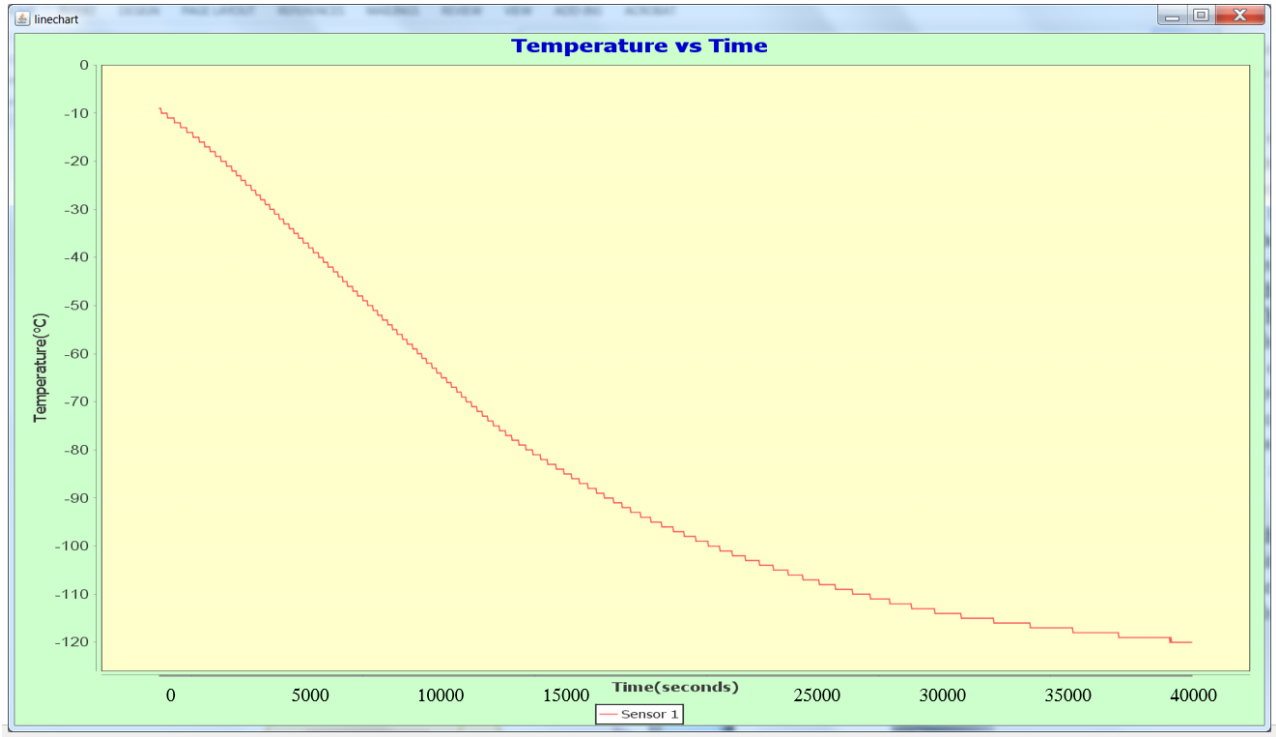

Fig 3: Temperature – Time Graph of a sensor

5. CONCLUSION

In this work, the graphical representation of the measured temperatures at definite intervals are shown on web application which were observed over a long time span process of cool-down inside the cryostat for testing mechanical components at liquid nitrogen temperatures. Temperatures at pre-identified locations were logged and the values were stored in mysql database. Web based monitoring of the cool-down process was provided with temperature verses time graph for individual sensor. This facilitates remote monitoring of the cool-down process in graphical format which were customized as per user requirement. In future, this application may be enhanced for plotting of observed values for all the sensors in a single screen. The application may be further developed to plot the online values of the cool-down measurements for real-time monitoring.

6. ACKNOWLEDGMENTS

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7. REFERENCES

[1] Prashant Khare et al. 2015. Design of a standalone Cryomodule for 650 MHz SCRF cavities of ISNS: New concepts and experimental results. In Proceeding of Indian Particle Accelerator Conference, TIFR, Mumbai.

[2] Wikipedia, https://en.wikipedia.org/wiki/Data_logger.

[3] Gosling, James; Joy, Bill; Steele, Guy; Bracha, Gilad; Buckley, Alex (2014).The Java Language Specification (Java SE 8 ed.).

[4] Gosling, James; Joy, Bill; Steele, Guy; Bracha, Gilad; Buckley, Alex (2014). The Java Language Specification (PDF) (Java SE 8 ed.).

[5] 1.2 Design Goals of the Java Programming Language. *Oracle. 1999-01-01*. Retrieved 2013-01-14.

[6] PAMUNGKAS, Agung Putra, Kenji HATOU, and Tetsuo MORIMOTO. "Evapotranspiration model

analysis of crop water use in plant factory system." Environmental Control in Biology 52.3 (2014): 183-188.

[7] Gilbert, David. "The jfreechart class library." Developer Guide. Object Refinery 7 (2002).

[8] HOU, Yu, and Wan-jun LIU. "Application of JFreeChart in Java Web Project [J]." Science Technology and Engineering 10 (2008): 044.

[9] Spector, A. Z. 1989. Achieving application requirements. In Distributed Systems, S. Mullender

[10] Ayushi Vishwakarma, Project report on Web - based graphical representation of cool-down measurements in Java , 2016.

[11] Swapnila Mundra, Devendra Sinnarkar, Rajiv Jain, "Conceptual Design of Web Portal Using Open Source Software for Diagnostic Centre", National Conference on Intelligent System, NCIS-2012, Chameli devi Institutions, Indore, 2012.

[12] Sinnarkar D., Jain R., Jana A.R., Kumar A., Vora H.S., Navathe C.P., "Akruti - Wrapper for Poisson SUPERFISH," in National Symposium on Nuclear Instrumentation, NSNI-2013 , Mumbai, 2013.

[13] Montoya, N., L. Giraldo, and A. Montoya. "Remote Monitoring and Control System of Physical Variables of a Greenhouse through a 1-Wire Network†." Advances in Systems, Computing Sciences and Software Engineering. Springer Netherlands, 2006. 291-296.

[14] GÜNGÖR, Ahmet, and Saadettin YILDIRIM. "Development and Testing of an Automated Computer-Controlled System for Plant production by Cutting." International Journal of Natural & Engineering Sciences 9.2 (2015).