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CURRENT PROGRESS IN THE DEVELOPMENT OF THE WEBGROUNDCONTROL APPLICATION

C. Newman, Univ. of Kentucky, Lexington, KY
Z. Agioutantis, Univ. of Kentucky, Lexington, KY
N. Schaefer, Univ. of Kentucky, Lexington, KY

INTRODUCTION

As underground mining continues to operate at deeper depths and in more complex geologic and geometric conditions, there has been an increased demand for higher design standards in ground control safety and stability within the mining industry. Over the past 20 years, NIOSH has developed, validated, and distributed a number of free software packages (ALPS, ARMPS, AMSS, ARBS, etc.) for the safe design of underground coal mines with respect to ground control. While these programs were initially developed on a, "stand alone model," where all program data resides on an individual or workgroup computer, modern day web applications have begun to migrate toward a, "multiple-tier model," allowing multiple users to access an application through an Internet connection.

webGroundControl provides users with access to NIOSH ground control design software (ARBS, ALPS, and ARMPS) utilizing a web-based three-tier architecture allowing users to easily access ground control designs, perform on-demand calculations, and provide online collaboration between operational personnel and engineers through a web server. Given advancements in cloud computing as well as the expansion of Internet connectivity on the surface and underground, webGroundControl users will be able to access the applications anywhere (where permissible) at any time. As web-based computing technologies continue to advance and cloud computing gains popularity and momentum, there is an industry need to develop Internet based applications for mine and ground control design (Barczak et al., 2016). The purpose of this paper is to introduce and familiarize those in the mining industry with the basic framework and, more specifically, the user-interface of the webGroundControl application. It is expected that the mining industry will rapidly embrace this new product and webGroundControl will be a new paradigm for mining engineering computer applications.

APPLICATION ARCHITECTURE

With the advent of cloud computing, web-based applications have become more popular with their adoption of multiple-tier, or n-tier, architecture containing independently operating tiers. The three-tier application architecture utilized in webGroundControl (as outlined in Agioutantis and Newman, 2016) contains a Presentation Tier (Web Server), Logic Tier (Logic/Application Server), and Data Tier (Data Server) as shown in Figure 1. While tiers have the ability to be deployed across and operating on multiple servers, webGroundControl is currently being deployed on a single server located on a university desktop computer. The separation of the application into a series of tiers greatly increases the maintainability and scalability allowing for the adoption of new technologies that can be applied to a single tier without redesigning the software package.

The Presentation Tier maintains the user interface translating client requests (through a web server) and displaying results (through a web browser). The Presentation Tier allows for on-demand access from multiple users and compatibility with a variety of personal computers, Smartphones, tablets, etc. on different operating systems. The Presentation Tier has been developed with respect to the HTML and JavaScript languages. Through the utilization of CSS, a coding language which describes the style of an HTML document, the webGroundControl display is able to spontaneously adapt to any browser and any screen. The development of the Presentation Tier will be discussed in more detail in subsequent sections of this paper.
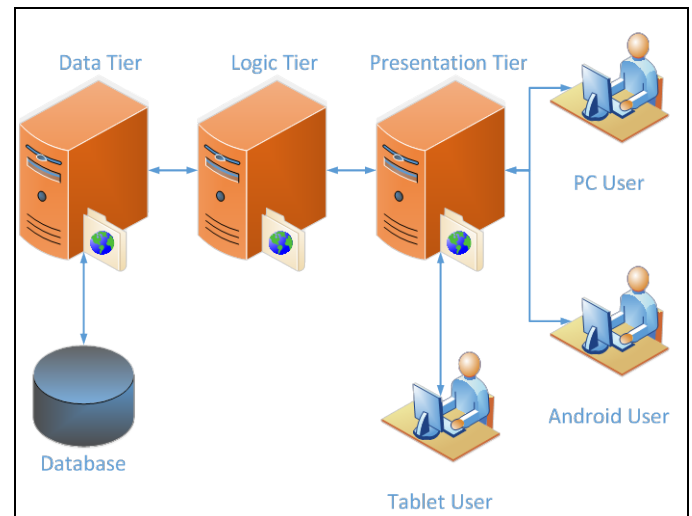

Figure 1. The three-tier application architecture utilized in webGroundControl.

The Logic Tier provides a means of communication between the Presentation and Data tiers as well as performing all necessary calculations for scenario analysis. User requests are sent from the Presentation Tier to the Logic Tier that completes the request by making queries to and processing the results from the Data Tier. The Logic Tier has been developed with respect to the Python coding language allowing for seamless interactions between both the Presentation (HTML and Javascript) and Data (SQL) tiers. Through the creation of a form-based structure, the Logic Tier is able to quickly receive, process, and distribute information throughout the application framework of webGroundControl. Through the creation of a robust Logic Tier, this server is able to effectively enforce the routes and methods by which data sets are accessed and updated.

The Data Tier authenticates user requests, and given the appropriate authentication rights, retrieves queried information from the database and reports information back to the Logic Tier. The Data Tier has been developed with respect to Firebird an open source SQL relational database management system and is where the database is accessed and maintained through robust data storage mechanisms. Utilizing these storage mechanisms preserve data securities as well as reduce data discrepancies within the database. The utilization of these storage mechanisms also allow for updates and changes to occur within the database without affecting either the Logic or Presentation tiers.

CURRENT BACK-END DATABASE DEVELOPMENT

Initial development of webGroundControl began with the creation of some basic back-end database mechanisms for user authentication, project management, and scenario management. The development of a user authentication mechanism involved the creation of a protocol for

logging into the webGroundControl platform. Given a unique username and password, procedures were developed for not only authenticating the user's password but also allowing for password changes and user role identifications being either a regular user or an administrator.

A back-end project management mechanism has also been developed which archives a user created project that will be available to the user upon selection. A project corresponds to a mine location with each project assigned a user defined number ALPS, ARBS, or ARMPS data also referred to as scenarios. Along with user access to a given project and its scenarios, the capability of project sharing has also been implemented allowing for easier group collaboration on mine designs.

Along with each project, a back-end data management mechanism has been developed for data storage and retrieval. A series of tables have been defined within the database allowing for the storage of data on a per scenario basis. Storage and retrieval, as well as general data management, has been developed with respect to the flask environment under Python 2.7. Data queries are set in the form of Object Relational Mapper (ORM) and the underlying SQL translator is responsible for moving data to and from the application.

CURRENT FRONT-END DEVELOPMENT

With the development of a generic back-end database work could be initiated on the front-end or Presentation Tier. Creation of the front-end user-application interface was subdivided into three parts; user authentication, user dashboard, and scenario modules. The creation of the front-end user authentication mechanism involved the creation of forms and queries for username and password login, password authentication, and utilities for password changes as shown in Figure 2.
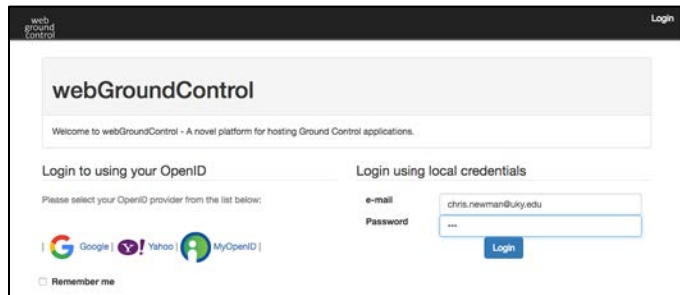
Figure 2. User Authentication Screen.

Given the appropriate authentications, users are able to access and update data sets through project management and data management mechanisms with respect to the front-end user-application interface. As shown in Figure 3, when users login to webGroundControl they will first be directed to the main user dashboard with navigation buttons located in the menu bar along the top of the display and access to project management (Select Project) as well as data management (ARBS Scenario, ALPS Scenario, and ARMPS Scenario) mechanisms.
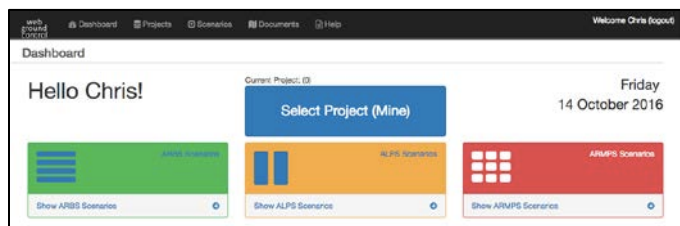
Figure 3. webGroundControl Dashboard.

Users are initially required to select a project (mine) to which their ABRS, ALPS, or ARMPS scenarios will apply by selecting the "Select Project (Mine)" button located both in the main display and menu bar. Users are then redirected to the Project Administration page (front-end project management mechanism) as shown in Figure 4. Here users are able to add, delete, and select different mine projects to which the

ARBS, ALPS, or ARMPS scenarios will apply. With a project selected, users are now able to create, edit, or delete ARBS, ALPS, or ARMPS scenarios related to that project (front-end data management mechanism). While the front-end aspect of all module scenarios will be developed in a similar way, at this point in the development of webGroundControl, only the front-end displays for the ARBS and ALPS modules have been created. By selecting a given module, for example ALPS shown in Figure 5, users will be directed to the Scenario Administration page where users are able to create, edit, or delete scenarios for the given module related to their selected project.
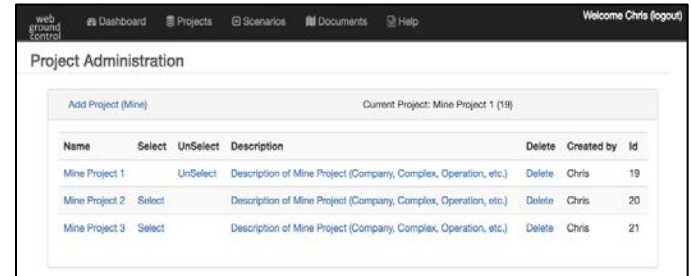
Figure 4. Project Administration.
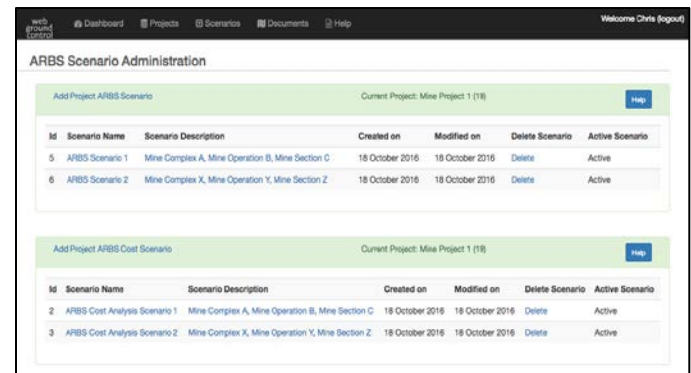
Figure 5. Managements of ARBS Scenarios.

If a user decides to create or edit a given scenario, they would be directed to the Edit Scenario Information page. Here users can make and save edits to default scenario parameters as shown in Figure 6. This input parameter form has been created through a series of HTML groups and tables. Each input parameter group has been defined with its own unique parameter tab. By selecting a given tab, users are able to view and edit tab related input parameters. The Cancel, Save, and Apply buttons at the top of each parameter group will either scratch user edits and return them to the Scenario Administration page, save user edits and return them to the Scenario Administration page, or Apply (submit) user edits while remaining in the current Scenario Edit page. Scenario output results are displayed and can be accessed at the bottom of the input parameter form as shown in Figure 6. Here users are provided with the most basic scenario outputs. If more detailed results are required, users can select Show Report which will direct them to the scenario output results page containing all input parameters and output results for the given scenario, see Figure 6. Further, users can print out this report by selecting Print to PDF (Figure 7). Additionally, users are able to perform parametric analyses for the given scenario using the available charting functions. Upon selection of a chart (Figure 8), users will be directed to a page displaying the given chart as well as the associated title, axes, and legend.

SUMMARY AND FUTURE WORK

For the past two decades, the ground control software developed and distributed by NIOSH has provided industry engineers with a series of tools aiding in the design of underground roof support, pillar stability for longwall and room-and-pillar mining, formation characterization, the prediction of roof conditions, etc. Through the development of webGroundControl, users will be provided with faster and easier access to existing ground control designs, on-demand field

calculations, as well as online collaborations between operational personnel and planning engineers. By discussing current back-end and front-end mechanisms, this paper introduces and familiarizes those in the mining industry to the basic framework and user-interface of the webGroundControl application.

Figure 6. ARBS Scenario Edit Form .

Figure 7. ARBS Results in PDF Format.
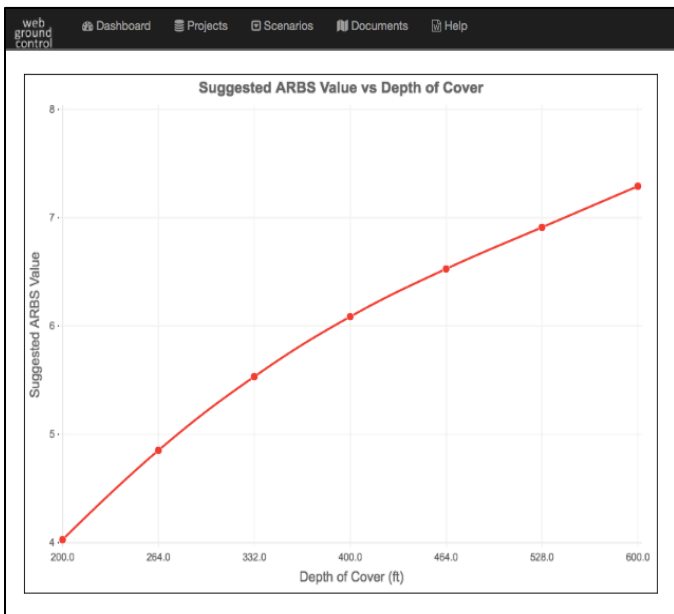
Figure 8. ARBS Parametric Analysis of Suggested ARBS Value vs Depth of Cover.

Presently, as of writing this paper, both the ALPS and ARBS modules are fully functional with the ARMPS module still under construction. Both the ALPS and ARBS modules have undergone a series of beta testing regimens for the purposes of further application debugging as well as insights into user-application compatibilities. The webGroundControl web-based application will be available to the industry in the summer of 2017.

REFERENCES

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