# Intelligent Analysis about Evacuation in Coal Mine Flooding Based on the Repast

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**Abstract: Intelligent analysis about coal mine water hazards simulate the flooding process and staff corresponding behavior. The program begin with the place where water gush severely, underground workers have their post responsibility and survival skills. In the whole simulation, casualties and direct economic loss can dynamic display. It provide the reference for prevention and control of water plan, improve the drainage system, and can strengthen water disasters forecast of excavating surface.**

***Keywords: artificial intelligence; coal mine water disasters; emergency evacuation; simulation; repast***

## I. INTRODUCTION

Artificial intelligence is a comprehensive technology involves the natural and social science, it has been widely used in the engineering industry[1].Minsky published the book thinking of society in 1986, put forward the idea of the Agent.Minsky thought solution of certain problems can be obtained through agreement in a society of individual Agent, the individual has the characteristics of social interaction and intelligent.Since then, the concept of the Agent is the introduction of artificial intelligence and computer field, and gradually become a hot research topic [2]-[4].Coal combustion, water, gas explosion, roof caving is mine catastrophe risk, using one of the major software Repast of Agent for water disasters accident emergency evacuation simulation and realizing the intelligent optimization analysis is an innovation in the field of computer aided disaster prevention and mitigation.

## II. PERSONNEL ACTIONS IN THE MINE ACCIDENT

The accident of water disasters once occur, the present work, should be possible to observe and quickly determine the location of the water inrush sources and water inflow, causes, damage degree, etc., and immediately report the mine operation department. At the same time, should use the reliable contact, in a timely manner to the lower levels and other personnel warning notice may be threatened area. Head accident early, field personnel should be on the scene and older workers' organization, led by using existing resources, quick to rescue work. The methods and measures should be based on the damage accident situation and the existing conditions and reasonable selection. If water bursting point surrounding rock hard and water inflow is not big, head can organize forces, local materials, strengthening working face, stuck in an outlet as soon as possible. At the top of the water, water fierce, unknown parameters for loose, never can be forced to block an outlet, lest cause working face water inrush large area, causing casualties, expand the situation. If the water is too hard to plug water point, also can not afford time to reinforce the working face, should have the organization along the intended route to avoid disaster, from the face into the nearby mountain tunnel, from wind Wells or master, during to the ground, the principle is to avoid the pressure head, quickly retreated to the upper level of the place of water or ground, and cannot be panicked into the near water inrush and the bottom of the cul de sac. Retreat can hold tent when beam, tent leg or other fixed objects, prevent water down and washed away. So old empty water gushed out, and the location of the poisonous and harmful gas concentration increased, the worker should immediately her with good isolation type self-rescuer or compressed oxygen self-rescuer. In the uncertain location of air composition can ensure the safety of the staff of life, forbid anyone to remove self-rescuer at random, in order to avoid poisoning. Rapidly in flooded, water flow under the condition of rapid, no time to evacuate to safe locations, mine personnel should immediately to avoid outlet and drain water, avoid to the high adit indoors, in turn, such as the sole head of below the only export has been drown to retreat, is in the cul de sac, to save trapped staff should keep calm and avoid excessive consumption. Person should immediately check the coal mine personnel at all levels, if it is found that there are persons stuck in the coal mine, rescue measures should be developed. When the emergency measures can stop flooded Wells, the coal mine remaining staff should shift to exit quickly, reach to ground safety.

## III. AGENT AND EMERGENCY EVACUATION INTELLIGENCE ANALYSIS

### A. *Use of Repast*

Repast of coal mine water hazards in building simulation model (CMWHS) is to design a state machine, the machine is the core of the state is the state of all members of the collective CMWHS attribute set. Members are divided into the underlying structure and surface structure. Repast is one of hundreds of classes, encapsulated in 11 in the library, in this paper, several main class library to expand: Analysis library by using the data sorting and mining DataRecorder class; Engine library is responsible for establishing, controlling and running CMWHS, simModel interface is the superclass of all model of Repast, library contained in the class is responsible for the control of roadway figure through a

 

graphical user interface processing, chronology and related behavior class is mainly used to change model of the state; GUI library for graphical interface shows a snapshot of the function and running the activities of the video production model, multiple Display classes and Space Space in the library work, the mining spatial location relationship of abstract and isolate the Display of spatial relations, can according to different mining Space characteristics of the design of visual Display; Network simulation class library includes the implementation Network, all kinds of special definition of the record of Network data classes; Space library mainly include the roadway class - the relationship between Space and flow, create multiple Agent in certain mining activities using the grid Space within a Space, grid Space is divided into many sections (sections), each section can accommodate more than one Agent, at the same time and according to the mining progress, the state of the grid can be constantly changing.

### *B. Realization of visualization*

At the beginning of the mine personnel retreat intelligence analysis, the damage and personnel, according to the essence, is to create a dynamic visual network diagram. With RasterSpace first class, a two-dimensional grid of coal seam showed CMWHS data points, with Object2DGrid class description of discrete two-dimensional grid. Through these two classes, the flow and the logic of the personnel movement on the RasterSpace, while visual on mobile at Object2DGrid implementation. CHDIM information need to the specific rules of coal seam a stream of data files, by tags to identify some relevant information in the file.

ncols 3000 / / according to the coal seam supporting density decide on the number of horizontal axis
nrows 3000 / / according to the coal seam supporting density decide on the number of vertical axis
xclcorner 539000.00 / / represent a coal seam origin x coordinate
yclcorner 687000.00 / / represent a coal seam origin y coordinate
Tunnelsize 30 / / represent each grid dominated two-dimensional coordinate aspect

Ranks with the two-dimensional matrix corresponding to the above nrows and ncols, matrix of each value represents a specific information, and these values will be in the process of flood analysis plays an important role, can use different values to represent some specific information and properties of the convention.Use 0 represents the undeveloped part of ore body, using a digital 2 on behalf of the mine main shaft, and other Numbers are used to represent the passes underground space, 1 on behalf of the general of roadway, 92 x (x represents any number) on behalf of the mining face in homework, 74 x (x represents any number) on behalf of the mining area of cul de sac. Fx (x is 1 ~ 3) represent the air duct, x (x is 4 ~ 7) on behalf of the coal mine main entrance etc., all want to use the identity of the information represented can be simplified as digital to join this represents the information matrix of coal seam, water flooded and evacuation from the analysis process, nature is a process of gradually deepened the flood information matrix.

### *C. Underground evacuation simulation operation process*

After starting the CMWHS, system initialization, first call the begin() function, through buildSchedule() method to set up the schedule model clock mechanism, control model in time according to the schedule after the appropriate method calls and operation, and then began to build concrete model, the execute buildModel() method, in this method involves the initialization model includes all of the objects, including underground space object, the flow object, object, and on behalf of the coal mine personnel container object and coal seam lattice points and so on. After completing the initialization of the model, create display mechanism, the first will need to create a display object to join a list for maintenance and update of the respective object namely ArrayList, then the object list by DisplaySurface addDisplayable() method will list these objects in a specific order, in turn, to join the display screen, and then through real-time synchronization refresh list of objects, according to dynamic display the behavior of each object. As addDisplayableProbeable() to create clickable (Probeable), when click on these objects will return a pop-up window, it will list some of the parameters of the object related state information. After initialization model success, when click the run button, CMWHS began to run. Simulation according to the established schedule perform, the schedule by constantly invoke step method to implement CMWHS analysis run. In the model of step() method in primary class CMWHSModel object by calling down each step() method to implement simulation run for all objects.At the end of the step() method is used to update the display: DisplaySurface. The updateDisplay(), by executing the sentence after each step of each object behavior change to display updates can realize dynamic simulation.

## IV. CONCRETE OBJECT CONTAINED IN THE OPERATION OF THE FLOOD SIMULATION

### *A. Person, PersonContainer, PersonFactory*

Person class that downhole working character class, as shown in Fig.1, mainly used for simulating evacuation behavior of class, also can through the different set of parameters to simulate different types of people, each Person must have a complete on its own state maintenance, such as the concrete position of the underground, at this time whether a torrent and their route of retreat. Person class has its own step() method calls a layer to the object, in this step() method, including the according to the current state of the Person to determine the action of this step should be performed, such as the current state of the Person's retreat, the implementation of Person retreat() method to move of Person, if the current state is trapped in the cul de sac state, execute the trapped Person() method.

PersonFactory class that is needed to create control downhole character class, by such invokes the person class constructor also give different parameter values, such as the need to construct figures position, age, survival experience of nature, can build a series of concrete construction method, for example creatWooder(),

creatRepairman(), creatHoler() method and so on can be constructed respectively timberman, the repairman and drilling work.Normally initialized object or add new characters during the simulation object used. PersonContainer class is responsible for many person class objects for scheduling and management of the system.Such major maintenance for two classes of person list: during initialization, using PersonFactory class constructor initializes the crowd and join the personList list; In this class and three state information is responsible for the statistical characters of method countPerson(), as the number of each segment can be statistics, personInjured() and personDrown() is responsible for the statistics the number of injured and drowning, the step() method call every step of downhole person() method, realize people retreat.Route of retreat is a maze algorithm (path), the maze algorithm has such a function: in a matrix space, once agreed representatives can pass data values, given a starting point and purpose of a point, it can automatically find out a. This design gives retreat route adjustment is convenient, can be through the random generation of the solution of the corresponding strategy, and real-time access to correct a route, can bypass the danger zone. For underground staff member is initialized, namely initialPerson() method, each type of person specific initialization to their jobs.

### *B. UnderSpace, UnderSpaceFactory, UnderSpaceContainer*

UnderSpace underground space namely, roadway, mining operation, mined-out area and so on, the space properties related to the water disasters have ripened red, sweat, air cooling, called, roof of the mist, water pressure, bottom up or producing cracks appear ooze water, water muddy, smells, etc. In the simulation runs, each person in the underground route retreat. UnderSpace class itself a statistical internal retention person number of counters, when a person enters a particular UnderSpace, this counter plus 1, whereas the counter minus 1, can achieve the goal of statistical number. When creating CMWHS view, to the counter and roadway properties are displayed near the UnderSpace logo, convenient for observation. In order to realize the flood Tunnel display CMWHS adopted symbol UnderSpace images in submerged degree show different marks at the same time, achieve the goal of dynamic pictures, similar can also join the voice prompt function.UnderSpaceFactory class is used to produce UnderSpace class, UnderSpaceContainer class that is used as a management UnderSpace class, this class is primarily a method used to initialize UnderSpace list initUnderSpace(), is used to complete the series of UnderSpace initialization.

### *C. Torrent, TorrentFactory, Torrent Container*

Torrent class that is formed in the subsurface water and flood submerged area. Can be set at the beginning of the analysis began in the worst flood hazard areas of water, and then according to the hydrologic setting water inflow, and can adjust water inflow. The gushing water generated by TorrentFactory, between water and water catchment water route, you must initialize the following parameters: the route load-point in the location of the cross section area and flow, flow velocity. Joined in the class for convenient setting method of flow parameters setTorrentParameter() can easily change the route parameters such as load-point, cross section and velocity. TorrentContainer class is important class, it is mainly responsible for collection of management flow and the formation of the algorithm. Torrent class has its own step() method calls a layer to the object, in this step() method, called the Torrent moveByPoint(), which based on the established route point list for mobile.Through setTorrentParameter() method gives Torrent a route, the route including a series of points through a list object to the Torrent, and then move() method according to the from high to low flows through each point in the list, arrives at the finish line form growing algorithm submerged().

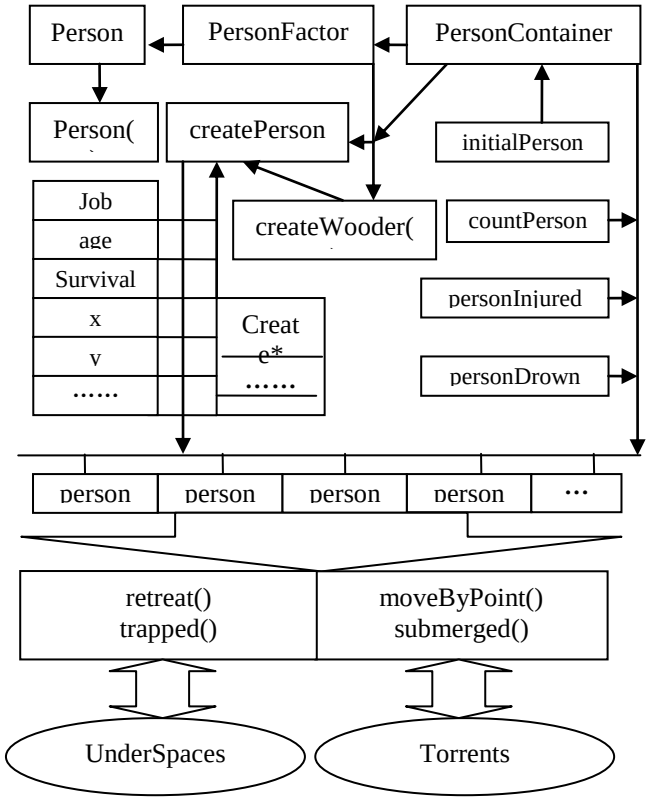


Figure 1. main object diagram

## V. OTHER IMPORTANT OBJECT

Point class is used to represent an arbitrary Point in the coal seam, it itself contains the coordinates of its own information, it is mainly used for auxiliary class Path to the solution of the optimal Path. The Path class is used to automatically generate path between two points, can use intelligent algorithm such as maze algorithm, ant colony algorithm to implementation, the Path class includes a main way to go () method, the method of parameter is a starting Point and an end Point, the return value is a class object contains many Point list. Point in the list of objects according to the order, the formation is a viable path.

InjuredandDrown classes are used to record injuries and drowned, underground work personnel, generated by the

Person and the Torrent.InjuredandDrownContainer classes are used to maintain a list of InjuredandDrown class, there can be multiple InjuredandDrown class object. ElectromechanicalDevice classes are used to record the state of the electrical and mechanical equipment, such as working status and damaged condition, generated by UndergroundSpace.ElectromechanicalDeviceContainer classes are used to maintain the list, which can have multiple ElectromechanicalDevice class object.

HydroGeologyandMine class is used to CMWHS import hydrological geology and coal information in class, this class provides information on the initialization and coal mine water disasters in the method, the method used in the two classes, one is Object2DGrid class, this class is used to generate a two-dimensional grid space, in CMWHS have the effect of pixel simulate the flood of information; the second is RasterSpace class, the class can handle specific text files, this mine information in a text file has associated with HydroGeologyandMine object. After the initialization of the successful execution, hydrological geology and coal information was successfully imported to the CMWHS, such Person, UnderSpace, Torrent interactive operation can be carried out in accordance with the development process of water disasters.

## VI. CONCLUSION

In the whole simulation, casualties and direct economic loss can dynamic display. The methods prepare the prevention and control of water planning and plan, improve the ground and underground waterproofing drainage system, for mining surface water disasters, organize the flood hazard, updates on prevention and control of water disasters drawings. Especially according to the investigation, simulation analysis can be made on the new situation, to promoted the safe production.

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