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Intelligent Management And Control System For Field Unmanned Driving Safety Based On Artificial Intelligence

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Abstract

This project involves the field of unmanned driving control technology, especially the field unmanned driving safety intelligent control system based on artificial intelligence, including server, data acquisition unit, protection early warning processing unit, prediction analysis unit, vehicle safety risk analysis unit, safety feedback unit, display unit and early warning unit;This project is analyzed from two perspectives: the planned driving path of the driverless vehicle and the body of the driverless vehicle, that is, the comprehensive analysis is carried out through formulaic processing and progressive way, which is helpful to make timely rectification on the specified driving path of the driverless vehicle according to the risk level,In addition, according to the risk level received, the unmanned vehicle shall be controlled according to the preset scheme to ensure the normal operation of the unmanned vehicle and the normal planning of the specified driving path, and improve the operation safety of the unmanned vehicle.

Keywords

Artificial intelligence, field, unmanned driving, intelligent control.

1. Preface

The harsh working environment such as high temperature, cold and windy in the field seriously affects the personal safety of field drivers, and also brings severe challenges to field safety production. Therefore, it is a general trend to promote an efficient, green and safe intelligent field operation system. At present, the technology of intelligent field operation is relatively mature, and the realization of unmanned operation is mostly in the mining and transportation links,The mining link can realize the remote control of the mining equipment and reduce the number of on-site operators, while the unmanned mining vehicle in the transportation link will gradually enter the mine site and start the pilot operation;

At present, the right of way and vehicle safety are the core of vehicle control and path allocation. However, due to the impact of transportation on the terrain of the loading area, the damage of the specified driving path greatly affects the transportation safety of driverless vehicles, and it is impossible to make timely rectification on the specified driving path of driverless vehicles according to the risk level of the specified driving path,It is very easy to cause damage to driverless vehicles and have serious safety risks. In addition, the long-term use of driverless vehicles will easily lead to serious tire wear, which will affect the braking safety of driverless vehicles;

For the above technical defects, a solution is proposed.

2. Technical Proposal

The purpose of this project is to provide an AI based field driverless safety intelligent management and control system to solve the technical defects mentioned above. It is to analyze from the two perspectives of the planned driving path of the driverless vehicle and the body of the driverless vehicle, that is, to conduct a comprehensive analysis through symbolic calibration, formulaic processing and progressive methods,It is helpful to timely rectify the specified driving path of the driverless vehicle according to the risk level, and control the driverless vehicle according to the received risk level, so as to ensure the normal operation of the driverless vehicle and the normal planning of the specified driving path, improve the operation safety of the driverless vehicle, and avoid dangerous driving.

The purpose of this project can be achieved through the following technical solutions:

The field unmanned driving safety intelligent management and control system based on artificial intelligence, including server, data acquisition unit, protection early warning processing unit, prediction analysis unit, vehicle safety risk analysis unit, safety feedback unit, display unit and early warning unit;The server generates the safe operation command and sends it to the data acquisition unit. When the data acquisition unit receives the safe operation command, it immediately collects the path data of the driverless vehicle. The path data includes the external environment data and internal cause data. The external environment data includes the real-time characteristic image of the road surface with the specified driving path and the full load weight value of the driverless vehicle,The internal cause data includes the tread depth and running speed of the driverless vehicle. The external environment data is sent to the protection early warning processing unit, and the internal cause data is sent to the vehicle safety risk analysis unit;After receiving the external environmental data, the protection early warning processing unit analyzes the external environmental data, obtains the risk section set U, and sends it to the prediction analysis unit. After receiving the risk section set U, the prediction analysis unit immediately obtains the full load weight value of the driverless vehicles in each sub time node and analyzes it to obtain the first level risk signalLevel II risk signals and level III risk signals are sent to the display unit;After receiving the first level risk signal, the second level risk signal and the third level risk signal, the display unit immediately controls the unmanned vehicle according to the preset scheme according to the received signal;After receiving the internal cause data, the vehicle safety risk analysis unit analyzes the internal cause data to obtain the safety signal, risk signal and danger signal, and sends the risk signal and reference safety coefficient CA to the safety feedback unit, and sends the safety signal, risk signal and danger signal to the early warning unit. After receiving the safety signal, risk signal and danger signal, the early warning unit,Make early warning operation of corresponding signal immediately;The safety feedback unit receives the risk signal and the reference safety coefficient CA, analyzes them, obtains the feedback signal, and sends it to the protection early warning processing unit. After receiving the feedback signal, the protection early warning processing unit immediately marks the risk signal as a danger signal and sends it to the early warning unit.

3. Analysis of external environment of protection early warning processing unit

The process is as follows:

Obtain the time spent from the end point to the start point of the specified driving path when the last unmanned vehicle is fully loaded in history, mark it as the time threshold, divide the time threshold into i sub time nodes, where i is a natural number greater than zero, and obtain the real-time road surface feature image of the specified driving path of the unmanned vehicle within the time threshold,The real-time feature image of the road is divided into o sub sections, where o is greater than zero natural number. The road depression depth of the specified driving path in each sub section and the total volume of ore before and after the vehicle head of the specified driving path are obtained, and the road depression depth and the total volume of ore are respectively marked as the road depression value Lo and the ore value So, and then the road coefficient of each sub section is obtained through the formula, where,A1 and a2 are the preset weight factors of the road subsidence value and ore value respectively, a1+a2=1.245, a1>a2>0, Mo is the pavement coefficient of each sub section, and sub sections that are greater than or equal to the preset pavement coefficient threshold are marked as risk sections g, g is a natural number, g is the number of sub sections that are greater than or equal to the preset pavement coefficient threshold, and at the same time, a risk section collection U is constructed.

The analysis process of the prediction analysis unit is as follows:

Obtain the difference between the corresponding full load weight values of the two adjacent sub time nodes and mark it as the rockfall value, then mark the corresponding sub road segment that is greater than or equal to the preset rockfall value as the abnormal road segment, build the abnormal road segment collection V, mark the intersection of the risk road segment collection U and the abnormal road segment collection V as the damaged road segment t, t refers to the number of damaged road segments, t is the natural number,Obtain the pavement coefficient Mt corresponding to the damaged road section and the shaking angle Qt of the driverless vehicle, and obtain the historical road condition risk coefficient MQt of each damaged road section through the formula. Retrieve the preset road condition interference threshold from the server, and the preset road condition interference threshold is expressed as the change value set for the next driverless vehicle,Then, the product of the historical road condition risk coefficient and the preset road condition interference threshold is marked to predict the road condition risk coefficient YCt, and the predicted road condition risk coefficient YCt is compared with the preset road condition risk coefficient interval entered and stored internally. If the predicted road condition risk coefficient YCt is less than the minimum value of the preset road condition risk coefficient interval, a level 1 risk signal is generated;If the predicted road condition risk coefficient YCt is within the preset road condition risk coefficient range, a secondary risk signal is generated;If the predicted road condition risk coefficient YCt is greater than the maximum value of the preset road condition risk coefficient interval, a three-level risk signal is generated.

The internal cause data analysis process of the vehicle safety risk analysis unit is as follows:

Obtain the tread pattern depth at the starting position of the driverless vehicle and the tread pattern depth at the ending position within the time threshold, and mark the difference between the tread pattern depth at the starting position and the tread pattern depth at the ending position as the driving wear value, so as to obtain the single position time tread pattern wear value DH;Obtain the driving speed Xi of driverless vehicles in each sub time node, so as to obtain the average driving speed PV of driverless vehicles;The operating safety factor YA is obtained through the formula.

The analysis process of the operating safety factor YA of the vehicle safety risk analysis unit is as follows:

Retrieve the default operating safety factor fault tolerance critical value P of the driverless vehicle from the server, and mark the product of the operating safety factor and the default operating safety factor fault tolerance critical value P as the reference safety factor CA,The reference safety factor CA is compared with the preset safety factor interval entered and stored internally: if the reference safety factor CA is less than the minimum value in the preset safety factor interval, a safety signal is generated;If the reference safety factor CA is within the preset safety factor range, a risk signal is generated;If the reference safety factor CA is greater than the maximum value in the preset safety factor interval, a danger signal is generated.

The analysis process of safety feedback unit is as follows:

Obtain the duration between the unmanned vehicle executing the brake operation and the completion of the brake operation, and mark it as the analysis duration. Obtain the temperature change curve of the brake pad within the analysis duration, obtain the maximum peak value and minimum trough value from the temperature change curve, and mark the difference between the maximum peak value and the minimum trough value as the maximum span value,At the same time, the corresponding time length between the minimum trough value and the maximum peak value is obtained to obtain the unit time temperature rise, and the difference between the unit time temperature rise and the preset unit time temperature rise alert value is marked as the risk value FX, and the risk coefficient FQ is obtained through the formula,And compare the risk coefficient FQ with the preset risk coefficient threshold entered and stored internally: if the risk coefficient FQ is greater than or equal to the preset risk coefficient threshold, a feedback signal will be generated;If the risk coefficient FQ is less than the preset risk coefficient threshold, no signal will be generated.

The alert operations of the alert unit are as follows:

The warning operation corresponding to the safety signal is to control the warning light on the driverless vehicle to be green;The warning operation corresponding to the risk signal is to control that the warning light on the driverless vehicle is yellow;The warning operation corresponding to the danger signal is to control the warning light on the driverless vehicle to be red.

4. Example 1

This project is an artificial intelligence based field unmanned driving safety intelligent management and control system, including server, data acquisition unit, protection early warning processing unit, predictive analysis unit, vehicle safety risk analysis unit, safety feedback unit, display unit and early warning unit. The server and data acquisition unit are connected by two-way communication,The server is connected to the protection early warning processing unit through two-way communication, the server is connected to the vehicle safety risk analysis unit through two-way communication, the protection early warning processing unit is connected to the prediction analysis unit through two-way communication, the vehicle safety risk analysis unit is connected to the safety feedback unit through two-way communication, and the server is connected to the display unit through one-way communication,The server is connected to the early warning unit through one-way communication.

The server generates the safe operation command and sends it to the data acquisition unit. When the data acquisition unit receives the safe operation command, it immediately collects the path data of the driverless vehicle. The path data includes the external environment data and internal cause data. The external environment data includes the real-time characteristic image of the road surface with the specified driving path and the full load weight value of the driverless vehicle,The internal cause data includes the tread depth and running speed of the driverless vehicle. The external environment data is sent to the protection early warning processing unit, and the internal cause data is sent to the vehicle safety risk analysis unit. After receiving the external environment data, the protection early warning processing unit analyzes the external environment data to determine the risk level of the driverless vehicle during driving,Then, according to the risk level, timely repair the specified driving path of the driverless vehicle, which helps to ensure the working efficiency and operation safety of the driverless vehicle. The external environment analysis process is as follows:

Obtain the time spent from the end point to the start point of the specified driving path when the last unmanned vehicle is fully loaded in history, mark it as the time threshold, divide the time threshold into i sub time nodes, where i is a natural number greater than zero, and obtain the real-time road surface feature image of the specified driving path of the unmanned vehicle within the time threshold,The real-time feature image of the road is divided into o sub sections, where o is greater than zero natural number. The road depression depth of the specified driving path in each sub section and the total volume of ore before and after the vehicle head of the specified driving path are obtained, and the road depression depth and the total volume of ore are respectively marked as the road depression value Lo and the ore value So, and then the road coefficient of each sub section is obtained through the formula, where,A1 and a2 are the preset weight factors of the road subsidence value and ore value respectively, a1+a2=1.245, a1>a2>0, Mo is the pavement coefficient of each sub section, and the sub sections that are greater than or equal to the preset pavement coefficient threshold are marked as risk sections g, g is the natural number, g is the number of sub sections that are greater than or equal to the preset pavement coefficient threshold, and at the same time, the risk section set U {M1, M2, M3,..., Mg} is constructed,And send the risk section set U to the prediction analysis unit;

After receiving the risk section set U, the prediction and analysis unit immediately obtains the full load weight value of the driverless vehicles in each sub time node, so as to obtain the difference between the corresponding full load weight values of the two adjacent sub time nodes, and mark it as the rockfall value, then mark the corresponding sub road segment that is greater than or equal to the preset rockfall value as the abnormal section, and construct the abnormal section set V,Mark the intersection of risk road section set U and abnormal road section set V as damaged road section t, t refers to the number of damaged road sections, t is the natural number, obtain the pavement coefficient Mt corresponding to damaged road sections and the shaking angle Qt of driverless vehicles, and pass the formula MQt=(Mt×Qt)(1+t)×(α+β)The historical road condition risk coefficient of each damaged section is obtained, where,αandβThey are the preset scale coefficients of pavement coefficient and shaking angle, respectively,α>β>0,α+β=2.876, MQt is the historical road condition risk coefficient of each damaged section, and the preset road condition interference threshold is retrieved from the server. The preset road condition interference threshold is expressed as the change value set for the next unmanned vehicle, and then the product of the historical road condition risk coefficient and the preset road condition interference threshold is marked to predict the road condition risk coefficient YCt,The predicted road condition risk coefficient YCt is compared with the preset road condition risk coefficient interval entered and stored internally:

If the predicted road condition risk coefficient YCt is less than the minimum value of the preset road condition risk coefficient interval, a level 1 risk signal is generated;

If the predicted road condition risk coefficient YCt is within the preset road condition risk coefficient range, a secondary risk signal is generated;

If the predicted road condition risk coefficient YCt is greater than the maximum value of the preset road condition risk coefficient interval, a three-level risk signal will be generated. The severity of risk signals at all levels will be ranked as Level 1 risk signal is less than Level 2 risk signal is less than Level 3 risk signal, and Level 1 risk signal, Level 2 risk signal and Level 3 risk signal will be sent to the display unit;

After receiving the first level risk signal, the second level risk signal and the third level risk signal, the display unit immediately controls the driverless vehicle according to the received signal to ensure the normal operation of the driverless vehicle and the normal planning of the specified driving path, and carries out the early warning operation of the corresponding risk level,That is, the first level risk signal corresponds to the warning operation: the broken road section is displayed in the form of text "waiting for renovation"; the second level risk signal corresponds to the warning operation: the broken road section is displayed in the form of text "timely renovation"; the third level risk signal corresponds to the warning operation: the broken road section is displayed in the form of text "re planning the route and renovation",Further, it will help to rectify broken lines in the planned driving lines according to the risk level, improve the driving safety of driverless vehicles and reduce the risk of falling rocks of driverless vehicles, effectively ensure the operating efficiency of driverless vehicles, and solve the existing safety hazards.

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5. Example 2

After receiving the internal cause data, the vehicle safety risk analysis unit analyzes the internal cause data to determine whether there are potential safety hazards in the driverless vehicle, so as to ensure the normal operation and timely maintenance of the driverless vehicle, and improve the safety of the driverless vehicle. The internal cause data analysis process is as follows:

Obtain the tread depth at the starting position and the end position of the driverless vehicle within the time threshold, and mark the difference between the tread depth at the starting position and the tread depth at the end position as the driving wear value, so as to obtain the single position time tread wear value, and mark it as DH,The greater the figure wear value DH per unit time, the worse the anti-skid effect of the tires of driverless vehicles, and the greater the safety risk;

Obtain the driving speed of the driverless vehicle in each sub time node and label it Xi, so as to obtain the average driving speed PV of the driverless vehicle, and reflect the operation of the driverless vehicle through the average driving speed, and obtain the operation safety coefficient through the formula, where,F1 and f1 are preset proportional coefficients of pattern wear value and average driving speed in unit time respectively, and f1+f2=1.445, f1>f2>0, YA is the operating safety factor. In addition, the preset operating safety factor fault tolerance critical value P of driverless vehicles is retrieved from the server, and the product of the operating safety factor and the preset operating safety factor fault tolerance critical value P is marked as the reference safety factor, labeled CA,The reference safety factor CA is compared with the preset safety factor interval entered and stored internally:

If the reference safety factor CA is less than the minimum value in the preset safety factor interval, a safety signal is generated;

If the reference safety factor CA is within the preset safety factor range, a risk signal will be generated, and the risk signal and the reference safety factor CA will be sent to the safety feedback unit;

If the reference safety coefficient CA is greater than the maximum value in the preset safety coefficient range, a danger signal will be generated, and the safety signal, risk signal and danger signal will be sent to the early warning unit. After receiving the safety signal, risk signal and danger signal, the early warning unit will immediately make an early warning operation corresponding to the signal,That is to say, the warning operation corresponding to the safety signal is to control the warning light on the driverless vehicle to be green, the warning operation corresponding to the risk signal is to control the warning light on the driverless vehicle to be yellow, and the warning operation corresponding to the danger signal is to control the warning light on the driverless vehicle to be red, thus helping to control the safety of the driverless vehicle according to the color of the warning light,It is also helpful to repair driverless vehicles in time, improve the operation safety of driverless vehicles, and avoid dangerous driving;

After receiving the risk signal and the reference safety coefficient CA, the safety feedback unit immediately obtains the duration between the execution of the brake operation and the completion of the brake operation of the driverless vehicle, marks it as the analysis duration, obtains the temperature change curve of the brake pad within the analysis duration, and obtains the maximum peak value and minimum trough value from the temperature change curve,The difference between the maximum peak value and the minimum trough value is marked as the maximum span value, and the corresponding time length between the minimum trough value and the maximum peak value is obtained to obtain the unit time temperature rise, and the difference between the unit time temperature rise and the preset warning value of unit time temperature rise is marked as the risk value FX, and the risk coefficient is obtained through the formula, where,B1 and b2 are preset weight coefficients of risk value and reference safety coefficient respectively, b1>b2>0, b1+b2=1.649, FQ is risk coefficient, and the risk coefficient FQ is compared with the preset risk coefficient threshold entered and stored internally:

If the risk coefficient FQ is greater than or equal to the preset risk coefficient threshold, a feedback signal is generated and sent to the protection early warning processing unit. After receiving the feedback signal, the protection early warning processing unit immediately marks the risk signal as a danger signal and sends it to the early warning unit. After receiving the danger signal, the early warning unit immediately controls the warning light on the driverless vehicle to be red;

If the risk coefficient FQ is less than the preset risk coefficient threshold, no signal will be generated.

To sum up, the project is analyzed from two perspectives: the planned driving path of the driverless vehicle and the body of the driverless vehicle, that is, through symbolic calibration, formulaic processing and progressive analysis, it is helpful to make timely rectification on the specified driving path of the driverless vehicle according to the risk level,Ensure the working efficiency and operation safety of driverless vehicles, and avoid dangerous driving;

Moreover, the historical road condition risk situation is judged from two dimensions of road surface coefficient and shaking angle, which expands the evaluation dimension of the planned driving path, and the analysis is more comprehensive. The road condition risk coefficient is predicted based on the historical road condition risk coefficient and the preset critical value of road condition interference, so as to expand the judgment dimension and improve the accuracy of judgment,Further, it will help to improve the driving safety of driverless vehicles and reduce the risk of falling rocks of driverless vehicles, effectively ensure the operating efficiency of driverless vehicles, and solve the existing safety hazards;

In addition, the safety of driverless vehicles is evaluated through in-depth and interactive information analysis of the internal cause data of driverless vehicles, and through two dimensions of pattern wear value per unit time and average driving speed, so as to improve the accuracy of judgment, and control the color of warning lights according to the obtained signals,It is helpful to control the safety of driverless vehicles through the color of warning lights, improve the operation safety of driverless vehicles, and conduct in-depth analysis on the risk of driverless vehicles with hidden dangers to ensure the accurate safety of driverless vehicles, so as to improve the accuracy and effectiveness of data.

6. Conclusion

(1) This project is analyzed from two perspectives: the planned driving path of the driverless vehicle and the body of the driverless vehicle, that is, through symbolic calibration, formulaic processing and progressive analysis, it is helpful to make timely rectification on the specified driving path of the driverless vehicle according to the risk level,In addition, according to the received risk level, the unmanned vehicle shall be controlled according to the preset scheme to ensure the normal operation of the unmanned vehicle and the normal planning of the specified driving path, improve the operation safety of the unmanned vehicle, and avoid dangerous driving;

(2) The historical road condition risk situation is judged from two dimensions of road surface coefficient and shaking angle, which expands the evaluation dimension of the planned driving path and makes the analysis more comprehensive. The predicted road condition risk coefficient is based on the historical road condition risk coefficient and the preset critical value of road condition interference, so as to expand the judgment dimension and improve the accuracy of judgment,Further, it will help to improve the driving safety of driverless vehicles and reduce the risk of falling rocks of driverless vehicles, effectively ensure the operating efficiency of driverless vehicles, and solve the existing safety hazards;

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(3) The safety of driverless vehicles is evaluated through in-depth and interactive information analysis of the internal cause data of driverless vehicles, and through the two dimensions of pattern wear value per unit time and average driving speed, so as to improve the accuracy of judgment, and control the color of warning lights according to the obtained signals, which is conducive to the safety control of driverless vehicles through the color of warning lights,Improve the operation safety of driverless vehicles, and conduct in-depth analysis on the risk of driverless vehicles with hidden dangers to ensure the accurate safety situation of driverless vehicles, so as to improve the accuracy and effectiveness of data.

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