AUTOMATION OF LOW PROFILE DUMPING TRUCK

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ABSTRACT

An underground mining operation has changed according to the evolution and the transportation system in underground mining is one of the important roles. The underground transportation of ore, men and materials has been developed from olden days from manually operated to Highly mechanized and at present the automation which is being rapidly growing and the progress in automation technology has led in increase of production and productivity. There are many kinds of transportation system adopted in underground mining mainly gravity transportation system, conveyor system, and locomotive system and the low-profile dumpers. Low Profile Dumping Truck (LPDT) used at present in shallow depth underground mines has found many modification in its design and operation system, but many of the accidents and other problems regarding operation of the truck has noticed keep the safety and production in point of view the project aims in building of the automated low profile dumping truck and other machinery like LHD (load haul dumper) has already done with automation and working efficiently, presently Sandvik and Volvo are working on automation which clearly shows the future is with automation.

Keywords: Low Profile Dumping Truck, Load Haul Dumper, Buzzer, Key Performance Indicators, Global Positioning System

1.0 INTRODUCTION

Underground mining has changed their operation systems in accordance with the evolution of equipment. Mine transport system has an important role in underground mining. The underground transport system of ores, men and materials are being developed from primitive hand operation to the mechanized and automated operation through the rapid progress of technology in equipment, leading to higher production and productivity. There are different types of transport systems adopted in underground mining like Gravity Transporting system, Conveyor system, Locomotive system and Low profile dumpers etc.

1.1 HISTORY OF THE PROJECT

Low Profile Dumping Truck (LPDT) used at present in shallow depth underground mines has found many modifications in its design. The dump truck is thought to have been first conceived in the farms of late 19th century Western Europe. Thorny croft developed a steam dust-cart in 1896 with a tipper mechanism. The first dump truck engine known appeared in 1904. Though it was powered by an engine, the materials being unloaded from the bed still relied on gravity. Improvements were made shortly thereafter and hydraulic mechanisms started to replace gravitational force for unloading. The first equipment that ran with a steam engine and used a hydraulic hoist was invented by Robertson Steam Wagon. In 1907, another company from Glasgow created another vehicle with a hydraulic system operating with a steam engine (centraltrucksales.net). All these modifications were mainly for improving its production and productivity. Even after many modifications there are problems which still exist related to safety concerns. This study is trying to improve the safety during LPDT handling.

1.2 REASON FOR SELECTING THE PROJECT

Mines can be dangerous environment; Collisions, Tipping, Backup accidents is just few examples of safety hazards faced mine

workers every day in mine, In many cases of underground metal mines as well as coal mines for the transportation of excavated materials LPDT has been implemented, LPDT which was introduced at the earlier days had lack of accuracy in many matter like avoiding accidents and control at haulage roadways during the working condition, At the time of loading material in to LPDT the loaded material was not up to mark it was some times over loaded and sometimes less loaded this effected on the production rate and increased the cost of transportation, To overcome such problems and other problems we have atomized the LPDT by using sensors for better results. By using LPDT we can achieve environmentally friendly mining and High production so we have chosen this project.

1.3 REQUIREMENTS FOR THE PROJECT

1. Weight Sensors
2. Cameras
3. Battery
4. DC Gear Motors
5. Buzzer
6. LED bulbs
7. Motor Driver
8. NodeMCU Wi-Fi

2.0 LITERATURE SURVEY

[1] J.M.Roberts, E.S. Duff, P.I.Corke, P.Sikka, G.J. Winstanley, J. Cunningham: This paper describes how many of the navigation techniques developed by the robotics research community over the last decade may be applied to a class of underground mining vehicles (local haul dump (LHD) and haul trucks). We review the current state of the art in this area and conclude that there are essentially two basic methods of navigation applicable. We describe an implementation of a reactive navigation system on a 30 tonne LHD which has achieved full-speed operation at a production mine.

[2] G.J.Winstanley: Artificial intelligence, computerized navigation, intelligent control, mining equipment, mining industry, neurocontrollers, robots, vehicles, computer vision, position control, cranes, industrial robots, mineral processing industry, closed loop systems, coal, digital simulation, synamics, electric drives, feedback, image segmentation, image sensors, laser beam applications, laser ranging, man-machine systems.

[3] Dr.Greg Baiden: The Automation in mining industry Automotive haulage trucks AHT improves safety, productivity and maintenance New Commitment .AHT cannot be seen as employee replacement The future of AHT in mining looks bright – implementation should be considered a priority to remain competitive and .Simulation bias must be avoided .Simulation can be used in real time to evaluate changes.

[4] Cihan H. Dagli: This paper is gives about the, Driverless haulage trucks have recently been developed for open pit mines. To predict the benefits of an Autonomous Haulage System (AHS), a deterministic/stochastic model has been created to compare AHS to a manual system by estimating benchmarked Key Performance Indicators (KPIs) such as productivity, safety, breakdown frequencies, maintenance and labor costs, fuel consumption, tire wear, and cycle times. The goal of this paper is to describe the driver/autonomous sub-models that function within a virtual 24/7 open pit mine operating with 9 trucks and 2 shovels to move ore to a crusher and waste rock to a dump.

[5] Breakdown frequencies, maintenance and labor costs, fuel consumption, tire wear, and cycle times. The goal of this paper is to describe the driver/autonomous sub-models that function within a virtual 24/7 open pit mine operating with 9 trucks and 2 shovels to move ore to a crusher and waste rock to a dump.

2.1 PROBLEM STATEMENT

Underground mining gives at most importance to safety, life is one which cannot be brought back and safety must be given the priority. Working area is prone to accidents which take place due to difficulty maintaining visual contact with on-foot workers and obstacles.

The major problems are undulated roadways, steeply inclined roads which causes difficulty in

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transportation, tipping is another safety consideration which is the levelling of the truck before unloading, when not parked on relatively horizontal ground, sliding of truck takes place. A lot of efforts have been made in minimizing the accidents which is related to LPDT by adopting sensors.

2.2 Objectives Of The Proposed Work:

1. To develop a self-operated LPDT.
2. To minimize the accidents and problems related to visibility and spillage of materials.
3. To avoid the over speeding of the LPDT.

3.0 METHODOLOGY

3.1 The Project Aims At Developing A Self-Operated LPDT:

As we know generally the major transporting vehicles accidents occurs due to negligence of driver. Even researches are going on to improve the safety of transporting vehicles. Many developments came like alcohol sensing detector, over speed sensing unit etc. We consider all these parameters and decided to adopt a self-operated technology. In self-operated transporting vehicle as shown in Figure 3.1. We avoid the driver so accidents can be minimized drastically. And in our mining industry we gave more importance on production so in self-operated low profile dumping truck we assure efficiency will be more compared to driver operated LPDT.

Self-operated vehicles act by distributing equal load to the four wheels both when the vehicle is loaded and unloaded, and adopting four-wheel drive, retarder and steering, our project is aiming for high-performance shuttling of this vehicle in both forward and reverse travel directions, thereby eliminating the need for K-turns at loading and unloading site.

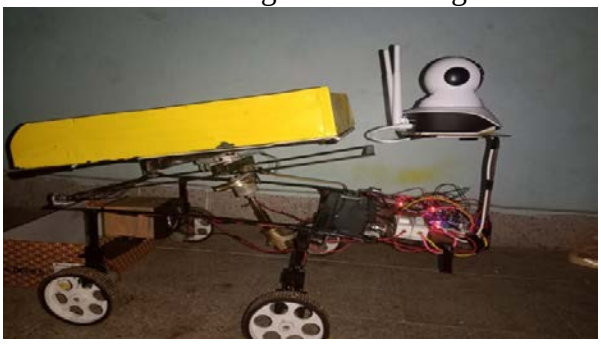

Figure1: Shows the Self Operated Low Profile Dumping Truck

3.2 To Minimize The Accidents Related To Visibility Problem By Installing Cameras:

In every mining accident where moving vehicles are involved the lack of all-round visibility shown in Figure 3.2 for operator has played a significant part. Until recently the cost of device to improve visibility has been relatively high but now even the most equipment costs less than a tire. Fitting will bring saving running cost of the vehicle as well as improving site safety. In our project we are adopting cameras to detect the obstacles and stop.

3.3 To Minimization of Spillage of Material by Installation of Weight Sensors:

Dumping trucks should avoid running over any material that has spilled onto the haul road. It can be especially hazardous in the winter, when it can harden, making it a bigger threat to truck tires. Even it is a loss in production so we adopted forcing sensor for detecting over load and to avoid spillage. Haulage of material is shown in Figure 3.3. The dumpers capacity is known and is calibrated in the OS, when the maximum weight is reached the sensors detect it and signals it with a sound and loading is stopped. Then the dumper moves in the path feuded and reaches to the dumping site and dumps the material and retraces the same path and ends back to the loading point. It doesn't have front or back it drives in both the direction so turning around is avoided and weight is equally distributed.

4.0 DEVELOPMENT OF PROTOTYPE MODEL

The model designed according to the conditions the main requirements of the model are weight sensors, buzzer, camera, motors, battery, motor driver circuit etc following is the process how the model is designed.

The model is built up with double framed chase of iron the dimensions of the model is (LxWxH) 18x13x3 in inches figure shows the chase frame.

4.1 Working principle:

The basic principle used is input and output of a program given, when a program is done according to the requirements the program is given as input and the expected results comes as

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output, Initially the programming is done and according to the requirements and operations to be performed by the model is given as input like, Forward moment, Backward moment, Right movement, Left movement and Lifting up and down, Weight limit Buzzer alarm, etc are given and for the storage of input data or program the nodemcu is used which is an open source IOT platform which has 32kb storage capacity which is being used in the model.

Nodemcu controller operates via Wi-Fi connection in the model, when the model or Wi-Fi kit is switched on and gets connected to the hotspot of the external sources the entire model comes in to control, the output required like, forward moment, backward moment, lifting up and down, Weight limit buzzer alarm etc are connected to the nodemcu output pins.

When the model is turned on and gets connected to the hotspot and then controlled by blynk application. This is known as output of the program which is stored as input in the nodemcu controller, the 360^0 camera is used to see the roadways and for object detection by using this we can control the LPDT.

4.2 FUTURE DEVELOPMENT

In the future developments of LPDT are:

1. **Location:** In further development the GPS (Global Positioning System) to be installed to check the exact position and track the truck position where the truck is moving.
2. **Real time monitoring:** for the real time monitoring raspberry pi 3 controller to be used as we know that the truck is to be operated underground at long depth.
3. **Wi-Fi Signals:** The raspberry pi is operated through Wi-Fi signals in underground the long range Wi-Fi signals and Wi-Fi boosters are used.

5.0 FIELD TEST

The prototype model field test is conducted on the field and reading is taken includes the following:

Distance: The model is driven on the Field to note the distance and the model can travel by using the network.

Carrying Capacity: The theoretical value is about 1kg .To know weight limit of different material at field the test is conducted.

Cycle Time: The time taken by the model to reach loading point for loading and to return the unloading point the time is calculated and also time taken for loading is also calculated

Loading Time: The time is taken for fill the LPDT.

Speed: The speed is also calculated.

Datas:

With Loaded hauling time for 5m is 52Sec
Empty hauling time for 5m is 31 Sec
Material = 830 grm
Unloading Time = 23 Sec
Speed = 60RPM

6.0 CONCLUSION

1] The main reason of this project is safety and increase in efficiency by adopting the camera for obstacle detection and force sensors for weight detection. The Future development can be added that is obstacle detection, navigation (GPS).

2] Self-operating is better safety, the lpdt operates on remote control from the surface. The weight sensor detects the quantity of material filled to the Lpdt and when it reaches maximum weight then it indicates with buzzer.

3] The new technology's designed for today's generation, the mobile app is good reference for operators, allowing instant access to information about the Filling of material a guide to better understanding unique features, and tips to High productivity.

4] The next-generation workforce and next-generation work practices will be dramatically transformed and influenced by the next phase of technological evolution. All companies will need to meet these new challenges in strategic corporate planning and greater workplace innovation to support evolving and disruptive business models.

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