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Complete Automation of Metro Stations through Artificial Intelligence

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Complete Automation of Metro Stations through Artificial Intelligence

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Abstract **-** Metro stations have become an invaluable transportation resource and will be spreading out of the metropolitan cities soon. It has reduced travel time and travel cost. We intend to research the possibility of unmanned metro stations through the application of artificial intelligence, one of which is expert systems. Expert systems –that are able to hold the accumulated knowledge of different domain experts can be implemented to guide the commuter about the optimum travel route. In this way the metro stations can be turned into self-sustainable structures.

Keywords **-** *metro stations, expert systems, artificial intelligence.*

I. INTRODUCTION

A metro station is an electric passenger railway for rapid transportation in urban areas. It comprises of underground tunnels, elevated rails and is multi-level at the stations. The metro station has several entrances for ease of access. The commuters are directed towards the entrances with the help of logo marks. It is connected to significant buildings by direct enclosed hallways .The metro stations also exhibit art and beautiful architecture. It has reduced travelling time and cost for the public. Its contribution to curb pollution is significant when the issue of global warming is alarming. In some metro stations the entire platform is screened from the tracks by a glass wall and consists of automatic platform-edge doors. In such a scenario, it becomes mandatory for the approaching train to arrive at a slow speed to halt in alignment with the doors. Ventilation of the platform is taken care of according to the weather, heated or cooled. Metro railway has high capacity and frequency to cater to the public. It has grade separation from other traffic. Grade separation refers to the method of aligning a junction of two or more surface transport axes at different heights.

Fig. 1: Underground tunnel

Now, we will consider an example of the Delhi Metro to analyze the figures associated with a metro station. Later, we will talk about, why we should automate and then discuss how we can automate.

Fig. 2: Elevated rails

II. CASE STUDY: The Delhi Metro

The Delhi Metro serves Delhi, Gurgaon, Noida and Ghaziabad. The network consists of six lines. It has a total length of 189.63 kilometers. There are 142 stations out of which 35 are underground. It is a combination of elevated, at-grade (on the same level) and underground lines. The Delhi Metro was built and is operated by the Delhi Metro Rail Corporation Limited (DMRC). DMRC operates around 27000 trips between 06:00 hrs – 23:00 hrs with an interval of 2 minutes 30 seconds between trains at peak frequency and otherwise with an interval between 3 minutes – 4 minutes 30 seconds.

Fig. 3: Platform screened from the tracks

Due to population increase in the city, number of coaches has been increased from 4 to 6. The four lines are Red line(Dilshad Garden to Rithala),Yellow line (Jahangirpuri to Huda city centre),Blue line (Dwarka sec-21 to vaishali/Noida City Centre) and Violet line (Central Secretariat to Badarpur).Power output is supplied by 25 Kilovolt, 50 Hertz alternating current through overhead catenary which are overhead wires used to transmit electrical energy .

Fig. 4: Multi-level at stations

On a daily basis, Delhi Metro has 1.6 million commuters. It is also certified by United Nations as the first metro rail and rail based system in the world to get "Carbon credits for reducing greenhouse gas emissions" and helping in reducing pollution levels in the city by 6.3 lakh tonne every year.

Fig. 5: Art exhibited at Mandi House metro station

Metro stations have services like ATM, food outlets, cafes and convenience stores. Eating, drinking, smoking and chewing of gum are strictly prohibited in the entire system to maintain order among the commuters. Sophisticated fire-alarm system is available for advance warning in case of emergency.

Over 3500 CISF personnel have been deployed to deal with law and order issues in the system, in addition to metal detectors, X-ray baggage inspection systems and dog squads. Intercoms are provided for emergency communication between passengers and Train operator. Periodic security drills are carried out at stations and on trains.

For ticket purchase, passengers can opt for either RFID (Radio Frequency Identification) token or Smart card. Tourist cards are also available.

Fig. 6 : RFID token and Smart card

III. RFID (Radio Frequency Identification) token

It uses a wireless non-contact radio system. Two-way radio transmitter-receivers called readers send a signal to a tag and read its response .The readers transfer the gathered information to computer systems running the RFID software. The tag's information is stored electronically in a non-volatile memory. The tag includes a small RF transmitter and receiver. An RFID reader transmits an encoded radio signal to interrogate the tag. The tag receives the message and responds with its identification information. The tag need not be in sight of the reader but can be embedded and can be read from several meters.

Fig. 7: RFID chip

IV. WHY COMPLETELY AUTOMATED METRO STATIONS?

- Machines can perform monotonous and tedious tasks repeatedly with tireless precision .It will completely remove any room for error as in case of human beings.

- It will increase the efficiency and effectiveness of the system as a whole.
- Travelling time can become more precise as the system will move towards complete automation without any human interference.
- Since work of an employee at a ticket counter is repetitive, it can be replaced by machines and the skills of that human resource can be invested elsewhere where it is more required. It will also cut-down expenses of the corporation investing in metro stations, since employees working at metro stations will converge to none.
- This can also bring down the ticket prices and make metro a more favourable mode of transportation among the public which will lead to lesser automobiles on the road, hence a greener planet.
- The installation of solar panels in place of glass windows can contribute in making it a self sustainable structure by lowering electricity bills and relying on power supply only for trains but not for lighting up the metro station approximately 17 hrs on a daily basis.
- The (self sustainable structures) metro stations will keep each and every other metro station informed about the arrival and departure of the trains, like human entities but in precise real-time and help curb power consumption further.
- If the security can also be automated using high end security devices and restricting Central Industrial Security Force (CISF) to patrolling and interfering only in case of an emergency, their skills can be put to better use in more violent parts of the country.
- It will be a onetime high investment with the vision of an economical long run.

V. MANNED LOCATIONS IN A METRO STATION TO BE AUTOMATED

- Ticket counters
- Security
- Shops

A. Use of KBS at ticket counters

The key idea is to separate the knowledge about the problem from the process by which the problem is solved. The separation of knowledge from control makes it easier to add new knowledge or remove existing knowledge if necessary. These systems have three basic components: a knowledge base in the form of facts, rules, frames or objects; an inference engine in the form of algorithms on how to control the processing; and a database.

The problem to be handled at a ticket counter is to suggest the shortest possible path from source to destination to the passenger. All the permutations and combinations of the routes connecting each and every metro station to the other on the network are to be stored in the form of rules in the Knowledge Base System.

The commuter will approach the ticket counter and interact with the Knowledge Base System. She/he will specify the source and destination .The inference engine will process the request and search through the Knowledge Base System for the best possible route in terms of time and travelling cost. The user can choose an intermediate stop in the above request which will act as a constraint and will have to be satisfied for the result to be valid.

If the time and cost factors of two or more routes are close to each other and the system is in ambiguity, it can display the short listed optimum possible routes for the user to choose one.

Once the passenger has enquired about the shortest path from source to destination, she/he will interact with the automatic TVM (Token Vending Machine).The Token Vending Machine will be the process of solving the problem. It will be coin-operated/Smart card operated and will dispense valid token after the commuter has entered the source and destination and has confirmed selections. After receiving the token, the person can move towards the platforms after verifying the token at the flap gate.

B. Security

The key responsibility of security is to detect passengers carrying arms and ammunition, hence removing the possibility of threat. They use metal detectors and X-ray baggage inspection systems. The way to automate security with least amount of human intervention is as follows:

Interchange the sequence of purchasing of token and passing through security check, i.e. every person entering the metro station will have to clear a security check which will be a very speedy process. Please see the diagram below in order to understand the process.

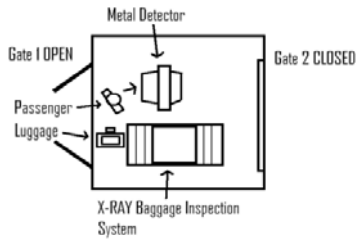

Fig. 8: Passenger enters the security check area.

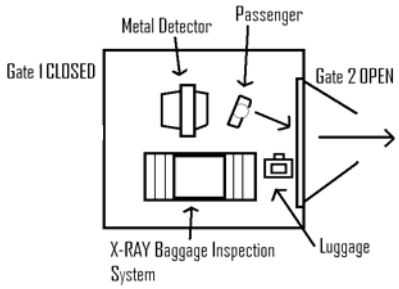

Fig. 9 : Passenger clears the security check and moves towards automated ticket counter

The Gate 1 (entrance to the metro station) will be open and will allow only one passenger to enter the security check area .The passenger will be monitored by close-circuit cameras for suspicious behavior in case of which the security patrol will be informed via telecommunication with a recorded message. The passenger will place his luggage on the X-Ray baggage inspection system and will then move past the metal detector to clear the security check. Only after the two checks are cleared the Gate 2 will open and the passenger can move towards the automated ticket counter. Please note that while the person is undergoing security check gate 1 is closed until that person clears the security check.

In case a threat has been detected, the two gates of the security check area will be locked automatically trapping the culprit. This can be implemented with the help of sensors and actuators installed inside the security check area. An alarm will go off; warning the public of the danger and a pre-recorded SOS message will be sent to all security units in and around the metro stations.

C. Automated Vending Machines

Food outlets and cafes can be replaced by AVMs (Automatic Vending Machine) .Although it isn't much of an application of artificial intelligence but it serves the purpose of making metro stations unmanned to an extent, hence appropriate. These vending machines are coin-operated or ATM card operated.

Fig. 10 : Automatic Vending Machines instead of food outlets

D. Solar panels to save electricity

For the metro station to be completely self sustainable after the ticket counter , security and shops have been automated to a great extent , it is required that they produce their own electricity for purposes other than running trains and be least dependent on power lines.

One way to achieve this is by replacing the glass panes by solar panels. The photo voltaic cells of the solar panels will directly convert sunlight into electricity and save power. It is an important step towards self sustainability because all other systems which will be responsible for automating metro stations run on electricity.

Fig. 11: Solar panels can replace glass window panes.

VI. CONCLUSION

Metro stations are restricted to metropolitan cities for now but it is likely that in the near future, each urban area might have a metro station for public transportation. By utilizing artificial intelligence and automating metro stations, we can make better use of human resource and minimize pollution. The different metro stations will coordinate among themselves through telecommunication more precisely in real time than human beings do with time lag. The frequency of trains will be a function of the rush observed at different times of the day avoiding unnecessary schedules and cutting down power consumption.

It will be a onetime high investment aimed at an economical long run.

VII.ACKNOWLEDGMENT

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