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Study of Different Obstacle Detection Methods in Railway Track

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ABSTRACT: Railway is major part of India and it is being the cheapest way of transportation today. Daily newspapers show different accidents in the railway track. Railway accidents caused by obstacles are the most important issues that should be solved. There are many methods used to detect obstacles in the railway track. This paper gives an idea about various methods of obstacle detection in railway track. Majority of methods use IR sensors to detect the obstacle. Machine learning approach does not detect obstacles with unknown classes. So it uses detecting obstacles by comparing input and reference train frontal view camera images. In Indonesia method used is by using infrared system which is placed in front of the locomotive, so when there are objects detected within a range distance, the indicator lights will light up. So that each method has its own advantage and disadvantages.

KEYWORDS: IR sensors, Obstacle, Machine learning, Camera images, infrared.

I. INTRODUCTION

The obstacle detection system is designed for safety applications in railway. A train is the popular conveyor of the people next to Bus. Railways are important part of a country. The automation of train is important as a mishap makes more damage to its travellers and the department. In order to achieve increased flexibility automated trains would be a promising step ahead. For the better quality of service and to operate the trains on the need of the passengers, many attempts were made to automate the operations. Many of these attempts try to give help to a train driver. A fully automated system consists of obstacle detection will help the locomotive driver to take immediate action based on the information passed.

Safety and reliability are highly notified in all transport systems. Nowadays, with the development of high speed railway, speed and capability of the trains constantly increased, and traffic density gets more and more serious. High speed train operation with high reliability and safety requirement enhances increasingly. However, safety of high speed railway extremely depend on its surrounding environment. The railway accidents due to train collisions shows world-wide an increasing tendency year by year. Ollier [1] noted that effective management of rail infrastructure will be vital to this development, upgrading, and expansion, particularly if coupled with a move to intelligent infrastructure [2]. Key part of the fully automated system is condition monitoring.

Automated train control is not a technical challenge any more due to the growing technology. The only thing which has not been automated yet is surveying the railway track with respect to obstacles. Today a human train driver reduces the risk of an accident by visual perception, triggering appropriate system reactions like whistling and/or braking [3]. Asking for fully automated train operation thus means requiring a technical system, capable of surveying the track in the same way as the human driver does. In fact, this requires a very high performance and reliability in detector and a wide detection range. Since the system has to operate in complex environments and under varying weather conditions. Several sensors are capable of obstacle detection. Known applications of automated track surveillance are limited to closed subway tracks (e.g. subway systems), are only operating under special conditions. This paper will introduce various mechanisms to detect the obstacles in the railway track. Average train accident would cost millions of Indian

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rupees and these can be avoided if there is a technique to track the obstacle location and warn the locomotive drivers about possible safety issues. However, in the case of railway, distant obstacles must be detected because the braking distance of a train is very long. In order to get increased flexibility and safety automated trains would be a promising step ahead.

This paper gives comparative study of various techniques to detect obstacles in the railway track. Paper is organized as follows. Section 2 describes about the related works. Section 3 wireless sensor network for railway safety. Section 4 presents results. Finally, Section 5 presents conclusion.

II. RELATED WORK

Researchers have been investigating on the detection of obstacles in railway track since 1960s. Today, India possesses the fourth largest railway network in the world. The recent information reveal that approximately 60% of all the rail accidents have derailments and obstacles on track as their cause, of which about 90% are due to cracks on the rails. Considerable measures of papers were published on this territory from that point. In paper [4] a method for detecting obstacles by comparing input and reference train frontal view camera images. In the field of obstacle detection, most methods use a machine learning approach, so they can only detect pre-trained classes, such as pedestrian, bicycle, etc. This means that obstacles of unknown classes cannot be detected. To overcome this problem, a background subtraction method that can be applied to moving cameras. First, the paper mentioned the method computes frame-by-frame correspondences between the current and the reference (database) image patterns. Then, obstacles are detected by applying image subtraction to corresponding frames. To detect obstacles by subtracting two image sequences, pixel-level alignment is needed. In the case of a train frontal view camera, since an image sequence is captured from a moving train, two image sequences must be aligned both spatially and temporally. To solve this, the proposed method first finds a reference frame captured at the most similar location to the current frame by image sequence matching. Then, it performs pixel-wise registration between the current frame and its corresponding reference frame. Finally, multiple image subtraction methods are applied to compute the image difference between the two frames, and obstacles are detected by integrating their outputs.

In 2013 NishaS.Punekar, Archana A. Raut [5] concentrates particularly on new type of autonomous train is developed. The localization system is constructed with GPS and GSM device. Mainly, three tasks, including collision detection, object detection, and obstacle avoidance, has been implemented on this platform. Developing on-board automotive driver assistance systems aiming to pass information to drivers about driving environments, and possible collision with other trains has attracted a lot of attention lately. Focus is on systems where the sensor is mounted on the train rather than being fixed such as in traffic/driveway monitoring systems. System consists of three main modules.

- The portable hardware component (GPS/GSM train locator unit)
- Central server part which handles receiving information from train
- Graphical User Interface part (GUI)

For the most up-to-date information about ongoing trips the GSM and GPS technologies are used. The basic concept of IR (infrared) obstacle detection will be transmit the IR signal (radiation) in a direction and a signal will be received at the IR receiver when the IR radiation bounces back from a surface of the object.

Another paper [6] presents an intelligent system which is based on image processing. Video surveillance is used to take snapshots at regular intervals which are compared for change detection. The output of the comparison analysis is used for obstacle detection. This system is expected to enhance the efficiency and accuracy of the Safety management system for railways to a great extent. This system uses CCTV cameras positioned at most of the accident prone areas. Initially a background snapshot is acquired which ideally contains of no such accident causing object. At every 15 seconds of predetermined regular intervals the CCTV camera will take the snapshots. Relevant background snapshots and current frame snapshots are stored in reliable database for easy retrieval.

The method used in Indonesia [7] is by using infrared system which is placed in front of the locomotive, so when there are objects detected within a range distance, the indicator lights will light up. To make a decision of reducing speed or to stop the train a light indicator will be given to locomotive driver.. The object detection sensor is mounted on the front of the train head and detects obstacles while moving forward. When the train is shifted into forward, the system is armed. Inside the driver room there are 2 LED display the glows (green and red), the green LED shows that obstacle is not detect although the red LED shows that an obstacle is within the range of the object detection sensor.

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The object detection sensor is using the infrared range finder system. The Infrared range works by emitted and reflected back (or not reflected at all). The light reflected back at an angle that is dependent on the distance of the reflecting object. The reflected light is collected by a lens and focused onto a photodiode inside the sensor unit. The reflected light shift phase is compared with the reference signal. From the number of shift phase, a required distance is calculated with good accuracy.

A multi-sensor obstacle detection system [8] for the use on railway tracks was specified, implemented and tested. The applied look-ahead sensors are: Video cameras (optical passive) and LIDAR (optical active). The objects given by the sensors were fused, classified and their description is sent to the central vehicle unit. To get maximum information about a fact object exploit the concept of complementary physical principles and strategies. To get maximum confidence in interpretation the concept of redundancy is used. Another concept is modularity: one can add new modules to the system till the claim is reached. It has been shown that the fusion of active and passive optical sensors and a railway track data base leads to very robust system performance. There are three kinds of sensors: The active optical sensors (LIDAR), the passive optical sensor (camera) and the virtual sensor (database, vehicle properties).

III. WIRELESS SENSOR FOR RAILWAY SAFETY

A wireless sensor network (WSN) is a wireless network consisting of spatially distributed autonomous devices using sensors to monitor physical or environmental conditions such as temperature, sound, vibration, pressure, motion[9]. A typical WSN system is created by autonomous devices, or nodes, combine with routers and a gateway. A central gateway, which gives a connection to the wired world where it can collect, process, analysis, and present the measurement data communicate wirelessly to distributed nodes. To extend distance and reliability in a wireless sensor network, use routers to gain an additional communication link between end nodes and gateway.

The base stations or control centres collect the data from the numerous sensor nodes distributed on the railway tracks. The sensed data is transmitted to control station using multilayer routing. Multi-layer routing is used; the nodes in the higher layer will receive the data from the nodes in the lower layer instead of transmitting it directly to base station. WSN condition monitoring will give continuous and near real-time data acquisition and autonomous data acquisition (no supervision is required); increased frequency of monitoring compared with manual inspection; improved data accessibility, data management, and data use related with non-networked systems as all data can be collected and processed centrally; the ability to coordinate data from a wide variety of sensors; intelligent analysis of data to "predict and prevent" events using intelligent algorithms; the ability to turn data into information about structures, infrastructure and machinery. WSN monitoring can be used to[10]:

1. Maintain process tolerance;
2. Verify and protect machine, system and process stability;
3. Detect maintenance requirements;
4. Minimize downtime;

There may be number of challenges with WSN. At rapid rates they generate large amount of data and often on an ad hoc basis. Multisource produce the data that has to be fused. The sensors will monitor the structure often exhibit complex behaviour, which is difficult to understand and interpret. Hence the data should be managed to provide a view of the system status. Sensor data are mixed with noisy data and sensors themselves can become defective wherever they are installed. Sensor data may have errors, where the sensors are available to harsh conditions as this exacerbates sensor and communication failures. Wireless sensor used in condition monitoring. WSNs need to minimize energy usage yet communication needs to be maximally efficient and communication requires energy, the data may be missing If there are errors in transmission across the WSN. Figure-1 shows the sensor arrangement in WSN monitoring.

A. *NEED FOR WSN IN RAILWAY:*

- The trains travels at a high speed and proper breaking distance needed to stop from the full speed.
- To safety receive of information and dispatch trains at a station.
- Railway signaling decides the number of train that can travel on a single day.
- By proper signaling the number of trains can be increased.

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- To control the movements of trains from one station to another with respect to movement of another train either in the same or opposite direction.

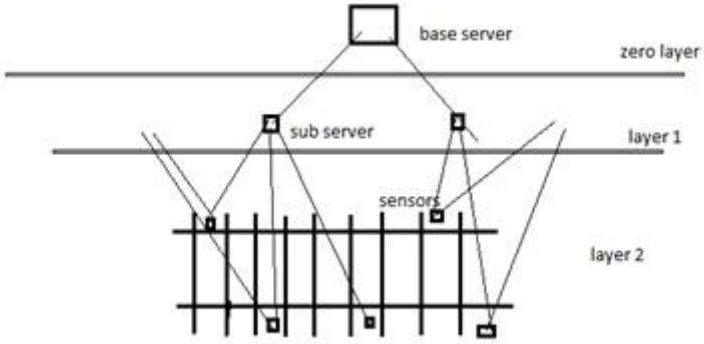

Fig -1: sensor arrangement in WSN monitoring

IV. RESULTS

Method Used	Limitation
Comparing input and reference train frontal view camera images	Unknown objects cannot be detected
IR sensor	Low resolution
Video surveillance is used to take snapshots at regular intervals which are compared for change detection	Presence of noise in image Changes in light conditions
CCTV surveillance	Need manual interactions
LIDAR	cannot used on the slab of the tracks

Table-1 Method and Limitation

Table-1 shows the different methods used to detect the obstacles in the railway track and the corresponding limitation.

V. CONCLUSION AND FUTURE WORK

This paper gives an idea about different techniques used to detect the obstacles in the railway track. Monitoring and maintenance by people is very difficult and takes more time. First IR sensor is used but, which is less efficiency after that uv-sensors are used for slab on the track only not for the crack detection. To avoid delays, it will use WSN for condition monitoring of railway track. So it immediately notifies and informs the current train comes on the track through wireless medium.

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BIOGRAPHY

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