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GPS Based Railway Track Survey System

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***Abstract*— Now a days due to natural disaster like floods, earthquake, cyclone, etc. there are many accidents are occurring in Railways due to cracks in the rails. System have some limitations and delay in delivering the signals, if the bridges or track got damaged, the information goes to railway authority people takes prolonged time and there by notifying and informing to the corresponding trains takes more time. So to avoid delays, our proposed system will immediately notifies and informs the current train comes on the track through wireless medium. Project discusses the technical and design aspects in detail and also provides the proposed multi sensor railway track geometry surveying system. This paper also presents the details of the implementation results of utilizing simple components inclusive of a GPS module, GSM Modem and Displacement based track detector assembly. Surveying system describes in this project is operational on both ballast and slab tracks. The system can be also operated in the tunnels with out any interruptions.**

***Keywords*— Global system monitoring, Multi Sensor, Modem, Surveying**

I. INTRODUCTION

Depending on recent developments in railway systems,high-speed trains are being extensively used, and rail transportation is being increased. Reasons for this increase are high speed, economical, environment friendly, safety, and modern characteristics of railway systems. These characteristics can be continued by periodical maintenance and control measurements. Depending on different factors, deformations may occur on the superstructure of railways. Determining these deformations on time and taking precautions is very important for the safety of railway systems. Classical geodetic measurement methods and instruments are currently used to determine railway deformations. The measurement process with these methods and instruments usually takes a long time. The fast growth in railways caused the necessity to provide speed and automation in geodetic control measurements. Different studies have been done to provide speed and automation in geodetic control measurements on railways. The Rhomberg system by Bahntechnik [1] and the GnBahn system by Geo++ [2] are examples of these studies. In [3], a method for the estimation and classification of a railroad curvature by onboard sensor data was developed.

The introduced surveying system in this paper is operational on both ballast and slab tracks. Track axis coordinates, which are railway geometrical parameters, are obtained with integrated Global Navigation Satellite System (GNSS) receivers. In addition, by means of motorized total stations, the system can be operated in tunnels without interruption where it is not possible to work with GNSS receivers.

II. COMPONENTS OF THE SURVEYING SYSTEM

A: AT89C51 Microcontroller

The AT89C51 is a low-power, high performance CMOS 8 – bit microcomputer with 4 Kbytes of flash Erasable and Programmable Read Only Memory (EPROM). The device is manufactured using an Atmel's high-density non-volatile memory technology and is compatible with the industry standard MCS-51tm instruction act and pin out. The on-chip flash allows the program memory to be reprogrammed in-system or by a conventional non-volatile memory programmer. By combining a versatile 8-bit CPU with flash on a monolithic chip, the At89S51 is a powerful microcomputer, which and solution to many embedded control provides a highly flexible cost effective.

B: Biaxial Inclinometer

A biaxial inclinometer by HL Planar Technique has been preferred to determine the super-elevation and gradient of the Railway. Depending on the UIC standards, the maximum allowed super-elevation value is 300 mm in the curves where the curve radius is bigger than 700 m [4]. When the curve radius is decreased, the maximum super-elevation value is decreased. Super-elevation values up to 384 mm can be determined by the preferred inclinometer on railways where the track gauge value is 1435 mm. The precision of the super-elevation value soon this railway is between 0.7 and 2 mm. The UIC standards for super-elevation can be achieved with this precision. The designed Surveying system operates at walking speed (0.5–1 m/s). To determine the super-elevation, centripetal acceleration on the inclinometer can be neglected. Its contribution is not significant for walking speed.

C. GNSS Receiver

Dual-frequency real-time kinematic (RTK) GNSS receivers have been used on the surveying system to determine the track axis coordinates. In the RTK GNSS measurement method, reference and rover receivers are used. The reference receiver has a radio transmitter that transmits the carrier-phase correction data. The rover receiver has a radio receiver that receives the corrections transmitted from the reference receiver [5]–[7].

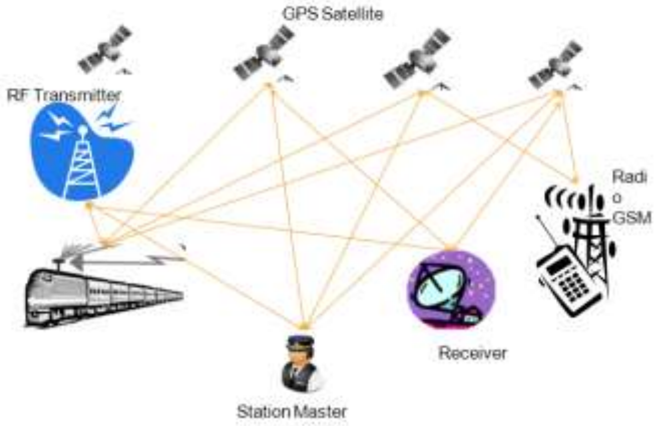


Fig. 1 shows the position determination with the GNSS

D. Total Station

The surveying system is also equipped with a motorized total station. Thus, the surveying system can be operated in tunnels without interruption where it is not possible to work with GNSS receivers. The integrated total station has an automatic target recognition (ATR) ability. A reflector on the surveying system can be tracked by the ATR total station when moving on the railway. With the ATR, the operator only needs to roughly point with the optical sight and trigger a measurement. The infrared beam transmitted from the total station telescope is reflected back by the prism and instantly analyzed. The total station moves the telescope, fine points to the center of the prism and measures. When the lock mode is enabled on the total station, the moving reflector can be tracked. After the initial ATR measurement, the total station remains locked onto the reflector and follows it as it moves. Measurements can be taken at any time. As intelligent software predicts the reflector movement, the total station continues to track even if obstructions cause short interruptions to the beam. If long interruptions should cause a complete loss of lock, the praetor must just quickly point again with the optical sight.

Fig.2 Designed surveying system.

Determining the Track Axis Coordinates

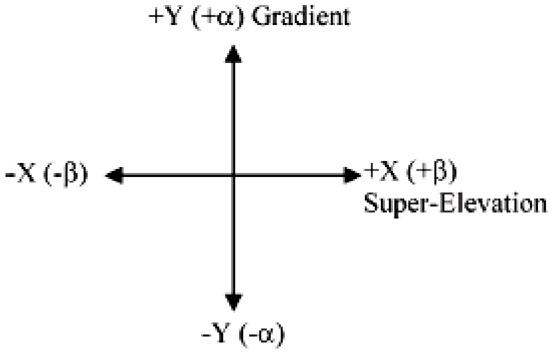
Track axis coordinates are determined with the GNSS receivers and total station. A survey pole that carries the GNSS receiver antenna and reflector is mounted on the surveying system Superposed with the track axis. Thus, if the super-elevation And gradient of the railway is zero, track axis coordinates can be directly determined. In curves or inclined railways, track axis coordinates cannot be determined from the GNSS and total station measurement directly. Because of the lateral and longitudinal inclination, measured values do not reflect the projected track axis coordinates. If the lateral inclination angle is β and the longitudinal inclination angle is α, which are obtained from the inclinometer, deviations from the projected track axis are defined by

$\Delta E = hG \cdot \sin \beta$ (1)

$\Delta B = hG \cdot \sin \alpha.$ (2)

β and α angles are obtained from inclinometer measurements.

Angle values on X ($-X$,$+X$) and Y ($-Y$,$+Y$) directions are determined by the biaxial inclinometer. The Y -axis of the inclinometer is oriented toward the railway track axis direction. so that the angle values on the Y -axis of the inclinometer reflects the gradient values of the railway. The X-axis of the inclinometer is perpendicular to the Y -axis and oriented toward the lateral direction of the track axis to determine the super elevation. While operating with the surveying system on the railway, four different conditions occurred. These conditions are the left–right super-elevation and the plus–minus gradient.



The inclinometer axes and four conditions are shown in Fig. 3

Determining the rail track axis coordinates is shown in Figs. 11–14 considering these four conditions. According to Fig. 9(a), the track axis elevation is defined by

$HOE = HA - hG \cdot \cos \beta$ (3)

Where HOE track axis elevation;

H_A elevation of the upper side of the survey pole obtained

by the GNSS or total station.

Where h_G elevation of the GNSS antenna or reflector from the railway plane.

By subtracting the $hG \cdot \cos \beta$ value caused by the super elevation from the HA elevation value, the track axis elevation can be determined. In [9], it is stated that the maximum allowed gradient value is 0.60% on railways. Taking this value into account, the $hG \cdot \sin \alpha$ value defined in Fig. 9(b) is calculated smaller than 1 mm, so that the deviation caused by the gradient the railway can be eliminated to determine the track axis elevation. Depending on the inclinometer axes in Fig. 10, when the right super-elevation (+β) and plus gradient (+α) condition occurred, the actual track axis on point 1 is measured on point because of the deviation caused by the super-elevation and gradient. The actual track axis coordinates on point 1 are determined by considering

E. Robot section

The Robot section consists of RF module, GPS, GSM, microcontroller, sensor and encoder.

F: GSM MODULE:

GSM was designed with a moderate level of service security. The system was designed to authenticate the subscriber using a pre-shared key and challenge-response. Communications between the subscriber and the base station can be encrypted. The development of UMTS introduces an optional Universal Subscriber Identity Module (USIM), that uses a longer authentication key to give greater security, as well as mutually authenticating the network and the user – whereas GSM only authenticates the user to the network (and not vice versa). The security model therefore offers confidentiality and authentication, but limited authorization capabilities, and no non-repudiation. New attacks have been observed that take advantage of poor security implementations, architecture and development for smart phone applications. Some wiretapping and eavesdropping techniques hijack the audio input and output providing an opportunity for a 3rd party to listen in to the conversation.GSM uses General Packet Radio Service (GPRS) for data transmissions like browsing the web. The most commonly deployed GPRS ciphers were publicly broken in 2011. The researchers revealed flaws in the commonly used GEA/1 and GEA/2 ciphers and published the open source "gprs decode" software for sniffing GPRS networks. They also noted that some carriers don't encrypt the data at all (i.e. using GEA/0) in order to detect the use of traffic or protocols they don't like, e.g. Skype, leaving their customers unprotected. GEA/3 seems to remain relatively hard to break and is said to be in use on some more modern networks. If used with USIM to prevent connections to fake base stations and downgrade attacks, users will be protected in the medium term, though migration to 128-bit GEA/4 is still recommended. Since GEA/0, GEA/1 and GEA/2 are widely deployed, applications should use SSL/TLS for sensitive data, as they would on Wi-Fi networks.

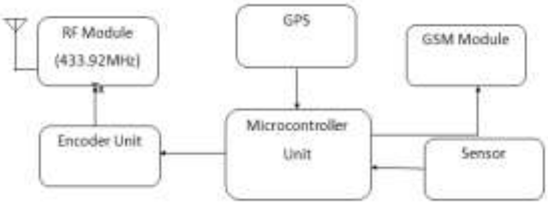


Fig:4 Robert Section

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G: Train Section

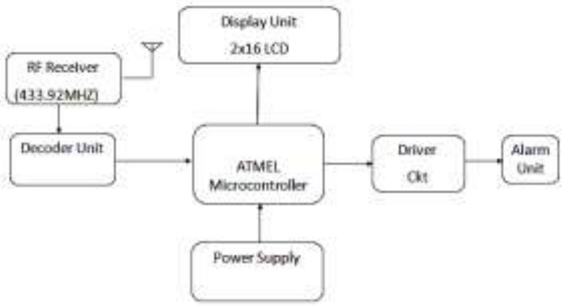

Fig 5: The Receiving Section

III. DATA PROCESSING

Data process using Mat lab using Fuzzy Based Obstacle Detection

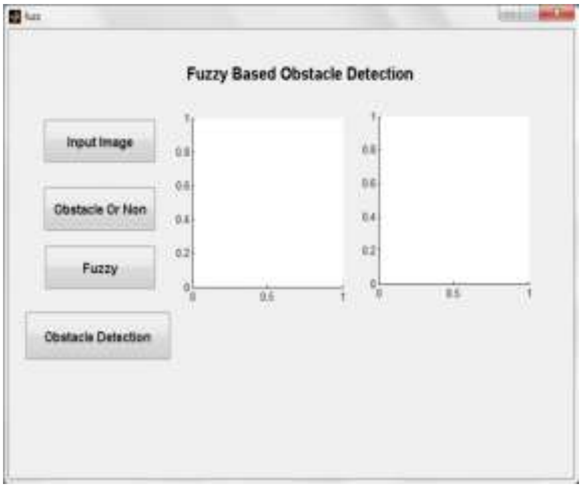

Fig:6 Fuzzy Based Obstacle Detection

Process completed

Fig:7 Fuzzy Based Obstacle Detection Process Completion

Obstacle Detected

Fig:8Obstacle Detection

BIOGRAPHIES

Mrs V.Mahalakshmi pursuing her Master of Engineering in communication systems at GKM college of Engineering and Technology, Chennai. She has completed her undergraduate in Electronics and Communication Engineering at S.A Engineering College Chennai.

Prof. K. O. JOSEPH is an Alumni of Officers Training Academy, Chennai. He passed out with Distinction from Officers Training Academy in March 1976. He has done various undergraduate and postgraduate courses in Military College of Electronics (MCEME), Secunderabad and has done Electronic Warfare Equipment Course (VHF Direction Finding) in Budapest, Hungary in 1984. He has Industrial Experience both in the Army Establishments (Workshops & Factories) and Civil. I was the Quality Assurance Officer for Missiles, RADAR and Communication Equipments in Bharat Electronics (BE), Bangalore in the DGQA (SQAEL) Wing of the Army during 1995 – 1999. He was passed M.TECH in Information Technology from Punjabi University with First class in 2004. He has also awarded Ph.D on Satellite Power control , from central Pacific University, USA and in communication Engg from Bharath University, Chennai. He received Commendation from Army Commander in 1987 and awarded Vishist Seva Medal (VSM) by the President of India in 1990.

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