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Fast Alert Information of Earthquakes or Volcanoes in HighSpeed Railway using Wireless DataNetwork

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Abstract

The seismic tremor or volcanoes have a genuine danger to the wellbeing of fast railroad activity. Sending quake early admonitions to trains in time is a significant way to maintain a strategic distance from or alleviate the impacts of debacles. As indicated by the specialized attributes of China's railroad portable correspondence framework, this paper proposes a remote information transmission plot for seismic tremor early admonition, which utilizes cell-based situating strategy to follow the trains' position and the quake early alerts are repetitively sent by methods for parcel exchanged information and cell broadcast short message. The test outcomes show that the proposed technique meets the necessities of quake early notice for fast railroads in China, and can understand the quick arrival of cautiondata.

Keywords: *High-speed railway, Fast warning of earthquake or volcano , GSM-R, GPRS, cellperformance.*

NTRODUCTION

Catastrophic events, for example, quakes are described by suddenness and vulnerability, which represent a genuine danger to the wellbeing of railroad transportation. For rapid railroads, trains run at fast and high thickness, even little scope debacles can prompt transportation problem or even lead to significant mishaps that jeopardize traveler wellbeing. For instance, on April 15, 2016, a 800 arrangement electric numerous unit (EMU) of the Kyushu Shinkansen in Japan was wrecked by the Kumamoto quake[1].

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Building a fast railroad tremor early admonition system (HSR-EEWS) is one of the significant ways to forestall or alleviate the effect of calamities on train's activity wellbeing. Right now of tremor event, the admonition data is shipped off the trains rapidly and dependably, setting off crisis estimates, for example, train speed breaking point and crisis slowing down. China is a nation with incessant quakes, and the geographical climate along the railroad is mind boggling. With the enormous scope development and activity of rapid railroads, the danger of quakes to prepare security is getting increasingly noticeable.

The utilization of remote information correspondence to communicate quake early admonition data is one of the techniques for tremor crisis measures. Important exploration proposes remote cross section network [2], remote sensor network [3] and different techniques to send notice data. China utilizes worldwide framework for portable correspondences railway(GSM-R) as the versatile correspondence foundation of fast railroad, and embracing GSM-R to convey quake early admonition data can send HSR-EEWSeasily.

This paper proposes a HSR-EEWS dependent on GSM-R, which utilizesthe GSM-R Cell-ID situating technique to gain the train position continuously. At the hour of seismic tremor event, the admonition data is at the same time delivered through broad parcel radio service(GPRS) and short message administration cell broadcast (SMS-CB), linkage triggers EMU speed limit activity or crisis slowing down. The test outcomes show that the proposed strategy can viably tackle the issue of tremor early notice data discharge for rapidrailroad.

EARLY INFORMATION OF EARTHQUAKE

The quake snappy alert system(EQAS) is a seismic tremor early admonition framework broadly utilized in Japan's Shinkansen, and its innovative work has become experienced and assumed a powerful function in tremor fiasco decrease [4]. On March 11, 2011, during the Great East Japan Earthquake, the EQAS of the Tohoku Shinkansen in Japan gave seismic tremor admonitions as expected, which assumed a significant function in guaranteeing the protected activity of the Shinkansen trains[5].

France's TGV Mediterranean crisis stop framework can consequently screen the quake and naturally delayed down or stop the train if fundamental following acouple

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of moments of the seismic tremor to keep the train from arriving at the harmed region at max throttle[6].

Notwithstanding proficient fields, there are numerous public situated tremor early admonition frameworks, for example, the Mexican seismic ready framework (SASMEX) [7], Japan's quake early warning(EEW) [8] and the tremor alerts systems(Elarms) in the United States [9], which can communicate quake cautioning to people in general through cell phones, TV, radio and differentmethods.

ANALYSING AND DESIGNING OF KEYTECHNOLOGIES

A. ProblemStatement

The guideline of tremor early notice dependent on remote information correspondence is to send the notice data to the influenced trains before the damaging S-wave shows up by utilizing the speed contrast between P-wave and S-wave, the speed distinction between electrical sign and seismic waves, as appeared in Fig.1.

At the point when HSR-EEWS identifies a tremor occasion, it ascertains the influenced railroad areas and the trains running inside these reach, and sends the admonition data to the trains by the GSM-R organization. There are two central issues for the arrival of caution data: one is to utilize a sensible remote information transmission strategy to rapidly send the data to the on-board types of gear; the other is to find the situation of the trains continuously to guarantee that the data is conveyed to the righttrain.

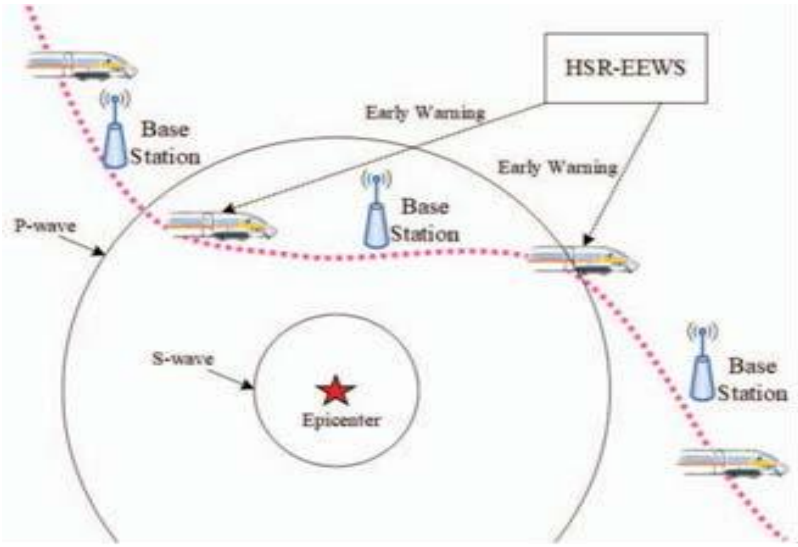

Fig. 1 The rule of seismic tremor early admonition dependent on remote information correspondence

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B. Transmission Mode for Wireless Data

The GSM-R can give an assortment of information transmission administrations, including circuit exchanged data (CSD), and GPRS, Short message service (SMS), and soforth.

1) **CSD:** Like voice calls, CSD utilizes a solitary GSMR timeslot to send information up to 9.6 kbit/s, which has the upsides of high dependability and brief pause. Nonetheless, CSD needsto distribute in any event one perpetual voice channel to every client, which enormously builds the heap of GSM-R organization.

2) **GPRS:** GPRS is a bundle exchanged versatile information standard dependent on GSM-R. It has the benefits of multi-client shared transmission capacity and enormous measure of communicated information, which can adequately improve the recurrence reuse factor. In any case, when the measure of GPRS beared information builds, it will bring rivalry issues of GPRSassets.

Furthermore, when the handover of versatile station happens, there will be an expansion in transmission postponement or bundlemisfortune.

3) ***SMS:*** SMS can be isolated into short message administration highlight point(SMS-PP) and SMS-CB, which is an instant message administration gave by GSM-Rorganization.

The beneficiary of a SMSPP is a specific portable client, while the beneficiary of a SMSCB is all versatile clients situated in a specific territory. SMS utilizes "best exertion" administration mode, and the nature of administration, for example, transmission deferral and achievement rate is mediocre compared to different administrations. Quake early admonition data discharge is a commonplace highlight multipoint correspondence mode, and SMSCB is more efficient thanSMS-PP.

The decision of remote information transmission mode needs to think about its specialized pointers and the attainability in viable designing applications. Table I thinks about CSD, GPRS andSMS-CB.

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Table I. Various types of GSM-R wireless data transmissionmethods

	CSD	*GPRS*	*SMS-CB*
Transmissiondelay	Low	Medium	High
Reliability	High	Medium	Medium
Resourceoccupation	Occupy1 timeslot	Multi-usersharing	Transmitted through thecontrol channel
Communicationtype	Point topoint	Point topoint	Broadcast
Deploymentcost	Low	Low	Medium

Under the circumstance that GSM-R network assets are progressively lack, if CSD mode is received, it will bring extraordinary difficulties to GSM-R network arranging [10]. The utilization of GPRS and SMS-CB to communicate tremor early admonition data is a sensible decision in functionalapplications.

C. Position of Train in RealTime

Fast and precise securing of the current situation of the trains is the reason of sending quake early admonition data to them. Right now, there are many train situating advancements, for example, balise-based situating strategies, satellite route, inertial route, and so forth [11]. The application framework can receive distinctive train situating advances as per its necessities and specialized qualities. All things considered, train situating necessities to meet the accompanying prerequisites: First, train situating administrations can in any case be given in passages, gorge and different territories to adjust to the unpredictable landscape states of railroad; Secondly, it is moderately autonomous and doesn't depend on other rail line application frameworks to offer situating types of assistance however much as could be expected, in this way upgrading the power of train situating under tremor conditions. Third, abstain from adding exorbitant situating helps and decrease development costs. Furthermore, the seismic tremor has the attributes of solid suddenness and enormous influence range, which has low necessities on train situating precision yet high prerequisites on situatingefficiency.

As per the prerequisites of HSR-EEWS, this paper proposes a train situating strategy dependent on GSM-R Cell ID, as appeared inFig.2.

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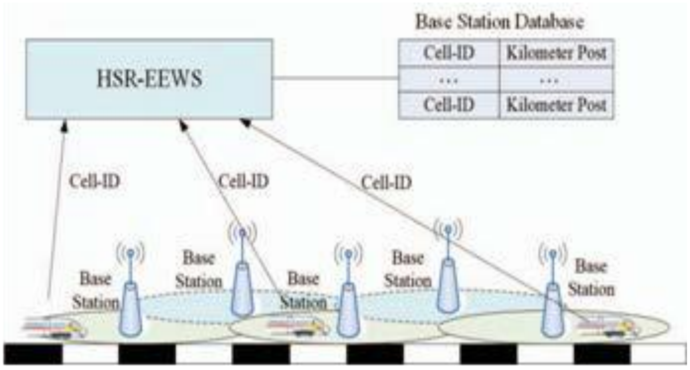

Fig.2 On-board hardware situating technique dependent on GSM-RCell-ID

The GSM-R cells are remarkably identified by Cell-ID. The on-board hardware sends the Cell-ID data of the current cell continuously to HSR-EEWS. The HSR-EEWS restores the base station's kilometer post as the train position as indicated by a pre-set up information base that stores the connection between Cell-ID and kilometer post. The exactness of this situating technique relies upon the span of the GSM-R cell and the distance between the train and the focal point of the cell. The more modest the cell span, the closer the on-board hardware is to the focal point of the cell, and the higher theexactness.

D. Transmission delay SMS-CB Process

One page of SMS-CB contains 88 bytes, which are separated into 4 fragments of 22 bytes in length. The message blocks are sent on the cell broadcast channel (CBCH), which can be partitioned into 8 vehicle blocks, likefollow

TB =(FNDIV51)mod(8)

Here TB is block number for Transport and FN for frame number ofGSM-R.

Regularly, the message will be sent in four successive different casings on the fundamental CBCH, where TB= 0,1,2 and 3, that is, the SMS-CB must be sent from the 0th vehicle block. The term of each CBCH cycle is eight 51-multiframes, which is about 1.883 s. In view of the above standard, the transmission of SMS-CB might be postponed, as appeared in Fig. 3.

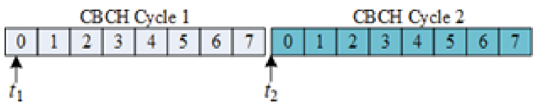

Fig. 3 Delivery cycle forSMS-CB

In the event that a SMS-CB shows up at t2, it very well may be sent right away. On the off chance that a SMS-CB shows up at t1, it can't be communicated inside CBCH cycle 1 and requirements to hang tight for one CBCH cycle to be booked for transmission. Let the SMS-CB send stand

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by time be ts, at that point ts ∈[0,1.8831]. Since the appearance of SMS-CB is totally irregular, adjust to an ordinary dissemination. It takes 4 vehicle squares to send one page of SMS-CB, and let the time needed for the on-board gear to get one page of SMS-CB be tr, at that point tr =0.941501s.

What's more, the transmission deferral of SMS-CB meant by tc likewise needs to consider the postponement of air interface tu, handling season of GSM-R network components tn, preparing season of versatile station tm, and so on, which can be communicated by the accompanying recipe:

$$t_c = t_s + t_r + t_u + t_n + t_m$$

Hypothetically, the estimation of tc isn't under 0.941501 s, yet it will be more terrible than the hypothetical incentive in the genuineworkplace.

SYSTEMARCHITURE

HSR-EEWS comprises of three sections: trackside hardware, remote information correspondence organization and on-board gear, as appeared in Fig.4.

The HSR-EEWS trackside gear computes the seismic effect range and figures out which trains are inside the reach, and communicates the tremor early admonition data to the on-board hardware's inside the specified range by GPRS. Simultaneously, a SMS-CB is produced, which is conveyed to all GSM-R cells in the quake influenced territory.

To improve the nature of administration of caution data transmission, data is sent simultaneously through GPRS and SMS-CB.

The HSR-EEWS on-board hardware secures the train position progressively and reports it to the trackside gear, gets the admonition data sent by the trackside gear, and issues a perceptible and visual alert or triggers the train crisis slowing down as per the sign of the noticedata.

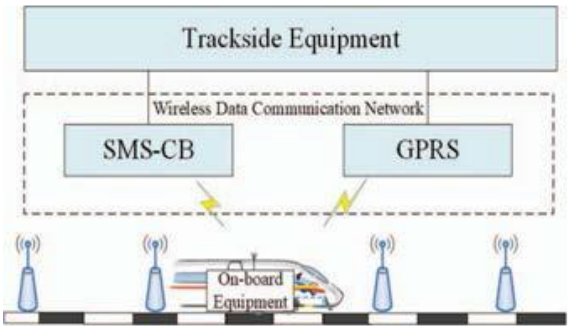

Fig. 4 HSR-EEWSarchitecture

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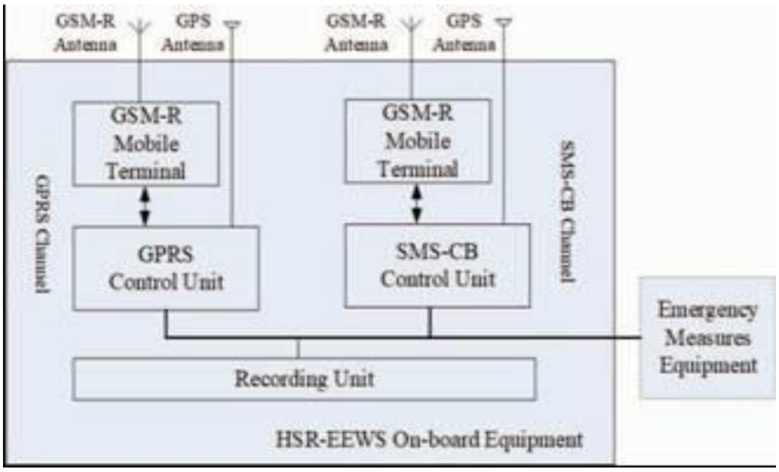

Fig.5. on-board equipmentdiagram

The on-board gear has two free accepting channels, as appeared in fig. 5, one channel to get and send GPRS information and the other channel to get SMS-CB. The two channels are free and practically excess, and any one channel gets the admonition data and advances it to the crisis estimates gear for relatingremoval.

The transmission deferral of quake early notice data is a key factor influencing the adequacy of HSREEWS. The more modest the deferral, the more extended the time held for train crisis measures. Let tg is the transmission delay of GPRS. Let tc is the transmission delay of SMS-CB. Now overall transmission delay has been given as

$$t = \min(t_g, t_c)$$

Where the capacity min (.) restores the base an incentive in its boundarylist.

EVALUATION

In this paper, under the state of rapid train activity, the HSR-EEWS trackside hardware is utilized to send mimicked quake early admonition data to the on-board gear, check the practicality of the specialized plan proposed in this paper, and aggregate appropriation function is utilized to assess the transmission deferral of caution data. This can be writtenas

$$F(x)=P(X \le x)$$

Where x is any genuine number, X is an arbitrary variable, F(x) is the CDF of X, and P(X ⩽ x) speaks to the amount of the probabilities of all qualities not exactly or equivalent to x.

A sum of 202 gatherings of mimicked tremor early admonition data were sent by the trackside hardware. As appeared in Fig. 6, the normal deferral of GPRS mode is 0.721 s, the normal postponement of SMS-CB mode is 2.9601 s, and the normal

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deferral of the two incorporated correspondence modes is 0.6701s.

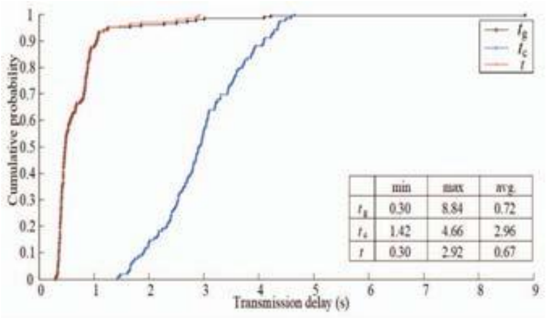

Fig.6: Transmission delay for fastalert message byCDF

It very well may be seen from the test outcomes that the transmission deferral of GPRS mode is superior to SMS-CB mode in general, yet the two strategies can supplement one another, and better execution can be acquired when quake early admonition data is sent in equal through two channels, and simultaneously, the vigor of correspondence can be improved.

CONCLUSION

GSM-R is a committed versatile correspondence framework for rapid railroads in China. HSR-EEWS can utilize GSM-R as the tremor early admonition data transmission stage; convey HSR-EEWS in the current fast railroad requiring little to no effort, and opportune illuminate the train to take essential crisis estimates when the quake happens. GSM-R is a restricted band remote accessinnovation with restricted information conveying limit. With the turn of events and advancement of railroad versatile interchanges to the future, the future rapid railroad tremor or volcano early admonition data transmission can accomplish more limited transmission delay and higher unwavering quality.

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