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A Survey on Proximity sensing techniques for Rail Track facilities for Event Triggering

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ABSTRACT: Rail track facilities are involved in dynamic testing of various payloads at required velocity to study the behaviour of system in that environment. During dynamic testing it is required to generate some commands i.e. triggering video camera, parachute opening, wing opening etc. on proximity sensing. The event can be generated by proximity detection or time based or combination of both. Time based means triggering an event after the time elapsed. It is also possible to calculate velocity from distance & time. The velocity derived can also be used to generate command. A microcontroller in combination with sensing hardware can be used for proximity sensing & generate a command on the basis of detection. This technique can also be applied in vehicle location, parking management, rail arrival & departure status, liquid level measurement and other fields.

KEYWORDS: Rail Track facilities , railways, ArduinoMicrocontroller , Embedded system, Hall effect sensor, Radio Frequency Identification (RFID), Dynamic Testing, Instrumentation, Ultrasonic sensing, Proximity Sensing, Event Triggering

I. INTRODUCTION

Rail track facilities are equipped with infrastructure i.e. rail track, payload, propulsion system, mechanical structure to carry payload on rail track & instrumentation. Rail track facilities required to generate some commands i.e. triggering video camera, parachute opening, wing opening etc. on proximity sensing during dynamic testing. Due to limitation of memory & battery power it is required to switch ON the camera on requirement or start data recording when required. This is achieved by generating a triggering command. Similarly, the wings of payload are supposed to be open when the vehicle carrying the payload has covered the required distance in a given time. Proximity sensing technique in combination with microcontroller can sense the proximity & generate the required commands more precisely and safely. Microcontroller based system provides more control over the system & simple to implement. For this reason, there is a requirement to develop a system which has intelligence, easier to handle & safe. Therefore, Microcontroller based proximity sensing & command generation system is required to have more preciseness, control & safety during trials.

Various sensing technologies i.e. RFID technology, Eddy current based sensors, Hall effect sensors, Ultrasonic ranging technology are the options that can be explored to sense proximity accurately during testing & generate the command for actuation. All these technologies are based on different principle. These technologies are free from the influence of light, electromagnetic wave, dust and other environment factors. Each technique of proximity detection has its own merit & limitation. It is aimed to develop a system that is capable of working at high speed safely, reliably & hardware is simple to implement.

Complex hardware is susceptible to vibration when vehicle carrying payload moves on rail track. These vibrations affect the system performance by introducing high frequency signals in the hardware depending on choice of proximity

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sensing technique. Then extra signal processing techniques are required for reliable & safe operation. Therefore it is always better to have simple hardware in terms of ease of handling & operation. There has been a continuous research going on in the field of contactless proximity/position measurement techniques. In this paper three proximity sensing techniques i.e. ultrasonic sensing, RFID & Hall Effect sensing are discussed.

The ultrasonic distance sensor is based on the principle of emitting a short Ultrasonic burst and then receiving echo pulse. The ultrasonic module emits a 40 kHz (ultrasonic) burst on receiving triggering pulse from microcontroller. This burst strike the target Object & the reflected signal is received back by the sensor. The sensor sends an output pulse to the host in response to echo detection. The width of this pulse is proportional to the target distance. The overall process of the ultrasonic sensing is shown in Fig. 1. The distance is calculated from the pulse speed & time taken by the pulse to travel to and fro from the target.

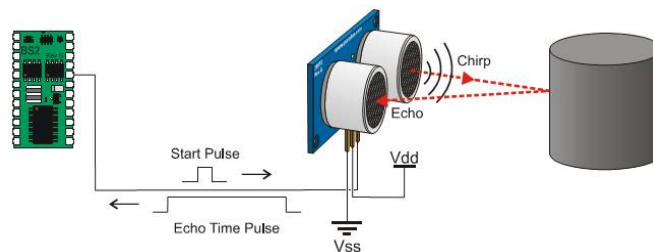


Figure 1: Ultrasonic Sensing Principle

RFID is based on principle of Radio frequency detection & identification. RFID tags are known as Active if self-powered and Passive if they draw power from the electromagnetic signals transmitted by reader. In RFID information between a tagged object and a reader/writer is transmitted wirelessly. The basic building blocks of an RFID system are Tags, reader, transmitting & receiving antenna & processing software on the host system as shown in Fig. 2.

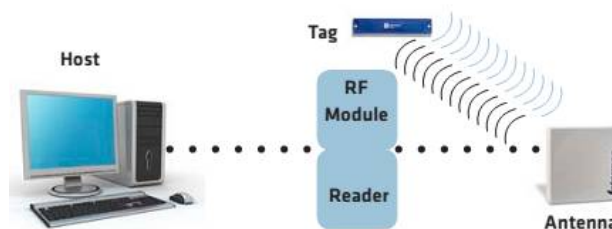


Figure 2: RFID Technology

The Hall effect is a good proximity sensing technique. A thin sheet of conductive material with output connections perpendicular to the direction of current flow is used as hall element. When hall element is placed in magnetic field, an output voltage proportional to the magnetic field strength is produced as shown in fig. 3. The output voltage is very small (μV) in range and requires extra signal conditioning to achieve valuable voltage levels. Hall sensor consist of hall element plus the signal conditioning circuitry. Hall sensor can be used to sense current, temperature, pressure. Hall sensor are of two types i.e. analog hall sensor & digital hall sensor.

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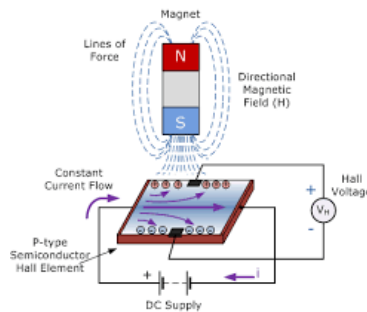


Figure 3: Hall Effect Sensing Principle

II. RELATED WORK

The various papers related to proximity sensing using ultrasonic, RFID & Hall sensor has been reviewed & summarized in this section in a sequence of ultrasonic, RFID & Hall sensor.

Carullo and Parvis(2001) observed that Ultrasonic wave propagation velocity is influenced by medium temperature. The wind component perpendicular to the path of the ultrasonic pulse will affect the measurement because of the speed of vehicle moving on track. The measured distance increases as pulse path increases. Experimental tests showed uncertainty increases with speed. The sensor works properly up to 30 m/s[1].

Thomas *et al.* (2014) discussed that proximity sensing using ultrasonic module depends on the pulse reflected by target to itself. The attenuation of received signal depends on the nature of the medium. It is also inversely proportional to distance between transmitter and target. The maximum distance that can be measured with this method is restricted by air medium[2].

Monisha (2015) discussed that distance measurement using ultrasonic sensor require three main factors, a medium, source and target. It is the utmost requirement for distance calculation using this device, that the target and ultrasonic wave plane of propagation should always be perpendicular. Hence the orientation of the target is a constraint to this system. The ultrasonic detection range is also affected by target size and position. Larger target will result in stronger reflected signal and this will improve the accuracy of distance calculated[3].

Dynamic *et al.* discussed that it is challenging to Detect and find vehicle positions in rail operation. The active RF tags mounted underneath the vehicle transmit vehicle identity periodically. RF readers mounted alongside the track are designed to amass the vehicle identity sent by Tags. This information is passed to the control system by reader [4].

Zhang *et al.*(2010) discussed that the active UHF RFID tag sends data to a reader. The distances between tag & reader should not exceed 300 feet (100 meters). Long range of UHF RFID improves connectivity duration between tags & reader. It indirectly increases the detection capability of reader at high speed. Secondly, RFID reader Range increases by using highly directional antennas in combination with narrow horizontal half-power. Lastly, the latency is reduced by fast response time of RFID tags [5].

Vera *et al.*(2016) discussed that efficiency of passive UHF RFID depends on the coupling between reader and tag antennas. This coupling is determined by channel parameters such as: link distance, Line-of-Sight (LoS) perturbation, antennas misalignment, scattering, losses by absorption from the obstacles, or an impedance mismatching caused by the obstacles in the surroundings of the antenna [6].

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Pan, Commins and Du(2015) observed magnetic flux distribution, the closer the Hall sensor is to the permanent magnets, the more flux will go through the Hall sensor; however, it also causes a larger flux aberrance. It was found that the magnetic flux distributions at 7mm away from the stator are more sinusoidal than the distribution on the path of 3mm and 5mm. The Hall sensor is mounted on the edge of the moving part above the permanent magnets. By suitable pulse shaping & filtering, this waveform can be processed & used by microcontroller to generate a command [7].

Ortiz *et al.* (2015) discussed the method to obtain high resolution proximity estimation using hall sensor. The proposed method include edge detector, direction detector, clock counter, conditioning, integrator, low resolution position estimation and addition blocks. The proposed method is based on calculating the duration between each edge and get the inverse of the time, that is, obtain the frequency of the pulses. Obtaining the speed, it can be integrated to obtain the position again, in this case with a differential time equivalent to the processing time [8].

Kim *et al.*(2016) discussed that the Hall sensor is insensitive to environmental contamination and external disturbance besides its small size & light weight. The amplitude of hall sensor signal is independent of velocity. The linear Hall sensor has finer resolution than square wave Hall sensor signal [9].

B. Baghli et al. (2013)discussed that the contactless position estimated by linear hall sensor can be further improved by data fusion between hall sensor & MEMS accelerometer. Double Integration of accelerometer data with proper calibration & filtering gives accurate position[10].

X. Zhang et al. (2015)discussed that a linear Hall-effect sensors is a decent choice for contactless proximity detection. A polynomial relationship exist between magnetic potential energy & hall sensor. The accuracy of proximity detection can be enhanced using fourth order polynomial [11].

III. BLOCK DIAGRAM

A Microcontroller based proximity detection and event generation system can be developed using Hall Effect sensing. Hall Effect sensing is based on magnetic detection. It will generate signal when it will come in proximity with magnetic flux. The magnet can be placed on the rail track at the location where event is required to be generated. When the rail vehicle carrying a Hall Effect based event generation system moves on track & come in proximity with magnet, a signal is generated. The pictorial system diagram is as shown in fig. 4.

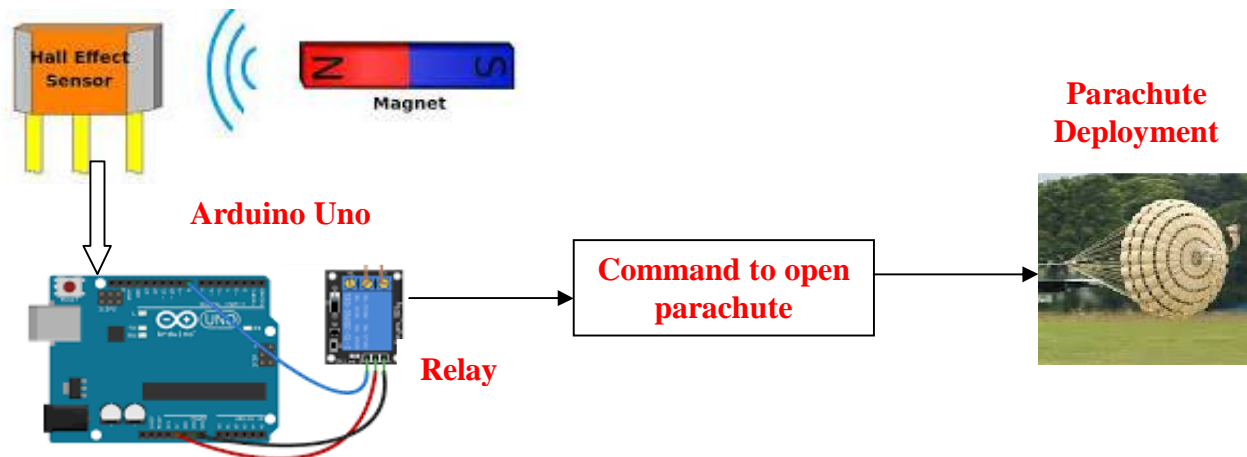


Figure 4: Hall Effect sensor based Event generation system

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The amplitude of signal generated is independent of velocity therefore the hardware & software complexity will be minimal. This signal will interrupt Arduino. Arduino will execute Interrupt Service Routine (ISR) & activate relay. This activation of relay will act as a command to generate an event i.e. opening of parachute. Multiple commands can be generated using multiple Hall Effect sensor and magnet combination.

IV. CONCLUSION

Ultrasonic sensor is limited by its susceptibility to temp & vibration. Moreover it cannot be used at high velocity & also depends on target orientation. RFID technology is not secure & chances of missing tag increases with velocity. Efficiency of such systems depends on antennas misalignment, scattering and surroundings of the antenna. Hall Effect sensor is best suited for rail track facilities because of its ability to withstand high velocity & vibration. It is also insensitive to orientation, environmental contamination and external disturbance. The output of sensor is also independent of vehicle speed.

REFERENCES

- [1] A. Carullo and M. Parvis, "An Ultrasonic Sensor for Distance Measurement in Automotive Applications," *IEEE Sensors Journal*, vol. 1, no. 2, pp. 143–147, 2001.
- [2] R. P. Thomas, K. K. Jithin, K. S. Hareesh, C. A. Habeeburahman, and J. Abraham, "Range Detection based on Ultrasonic Principle," *International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering*, vol. 3, no. 2, pp. 7638–7642, 2014.
- [3] S. Monisha, "Design & Development of Smart Ultrasonic Distance Measuring Device," *International Journal of Innovative Research in Electronics and Communications*, vol. 2, no. 3, pp. 19–23, 2015.
- [4] A. Dynamic, C. Co, H. Kong, H. Kong, and V. Detection, "A cost effective approach on Railway Vehicle Identification and Positioning using RFID technology," no. 1, pp. 490–493.
- [5] X. Zhang, V. Lakafosis, A. Traille, and M. M. Tentzeris, "Performance analysis of 'fast-moving' RFID tags in state-of-the-art high-speed railway systems," *Program for the IEEE International Conference on RFID-Technology and Applications*, June, pp. 281–285, 2010.
- [6] G. A. Vera, A. Abdelnour, M. Sarkis, A. Georgiadis, D. Kaddour, and S. Tedjini, "Passive RFID-enabled proximity sensor," *IEEE*, vol. 2016, pp. 31–33, 2016.
- [7] S. Pan, P. A. Commins, and H. Du, "Tubular linear motor position detection by hall-effect sensors," *IEEE*, pp. 2–6, 2015.
- [8] J. Ortiz et al., "High Resolution Position Estimation from Hall Effect Sensor," *IEEE*, pp. 5074–5079, 2015.
- [9] J. Kim, S. Choi, K. Cho, and K. Nam, "Position Estimation Using Linear Hall Sensors for Permanent Magnet Linear Motor Systems," *IEEE Transaction on Industrial Electronics*, vol. 63, no. 12, pp. 7644–7652, 2016.
- [10] B. Baghli and L. Khouane, "Position estimation of linear synchronous motor using Hall-effect sensors and a MEMS accelerometer," *3rd International Conference on Systems and Control. ICSC*, pp. 989–994, 2013.
- [11] X. Zhang, M. Mehrtash, and M. B. Khamesee, "Dual-Axial Motion Control of a Magnetic Levitation System Using Hall-Effect Sensors," vol. 4435, pp. 1–11, 2015.