Creative Construction Conference 2015 (CCC2015)

A big data-based workers behavior observation in China metro construction

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Abstract

Metro construction passes beneath through cities and has characteristics of straitness field and complicated surroundings, which lead to frequent accidents, especially because of worker's unsafe behavior. BBS is one of the construction safety management methods, aiming to observe, analyze and modify worker's behavior. In order to reduce the negative impact of limited behavior observation on BBS, this paper proposes the framework of behavior observation in China metro construction based on big data, which includes: (1) establishing behavioral risk knowledge base; (2) collecting image data reflected worker's unsafe behavior through intelligent video surveillance system and mobile app; (3) establishing big data cloud platform for storing data by distributed file manager. We verified its availability from an example that it can analyze semantic information contained in images effectively, extract worker's unsafe behavior knowledge automatically, retrieve the cloud platform quickly as well. Currently, this research has been utilized in partial construction lines in Wuhan metro and we have got massive valuable behavior observation data.

Keywords: Big data, Behavior observation, Unsafe behavior

1. Introduction

Nowadays, China's metro construction is entering a new period when construction speed and scale are both the first in the world, with 94 lines in operation, 120 lines in construction and over 150 billions gross investment . At the same time ,we cannot ignore the frequent occurrence of accidents which mainly because of worker's behavior. After studying nearly 75000 accidents, Heindrich found that 88% of safety accidents were due to worker's unsafe behavior[1]. Therefore, in order to reduce incidents and improve performance of site safety management, it's necessary to pay highly attention to worker's unsafe behavior[2]. It is also necessary to study behavioral safety because it turns out that unsafe behavior can be controlled by reasonable measures, even by workers themselves[3]. Behavior-Based Safety(BBS), also named Applied Behavior Analysis(ABA) in some other studies[4], is an effective way to conduct and encourage behavior improvement[5, 6] and focuses on what people do, analyzes why they do it,

and then applies a research-supported intervention technique to improve behavioral processes[7]. BBS was also applied in construction phase in some researches[8, 9], aiming to observe, analyze and modify workers behavior. containing the following steps: (1) listing unsafe behavior list which needed critical focus in construction site; (2) observing worker's unsafe behavior and recording its frequency; (3) giving feedbacks and correcting their unsafe behavior. Among above steps, step 2 is very significant. Past observation relied primarily on people, so there existed three problems: (1) time-consuming and hard-working; (2) need to observe numerous samples; (3) need worker's active cooperation. This paper introduced behavior observation method of metro workers based on big data, aiming to solve these problems by classifying, collecting and storing image data of site workers.

2. Framework of big data-based behavior observation

The framework of observation is shown in Fig. 1, including three parts: (1) data classification; (2) data collection; (3) data storage. Firstly, listing unsafe behavior according to the subway construction safety standards, operating instruction, accident cases and expert experience, then listing construction WBS (Work Breakdown Structure)-classifying worker's unsafe behavior in different construction phase and encoding, by combining with metro classification standard. The second step is collecting data which is derived from photos taken by monitoring videos and site workers(workers or managers), worker's unsafe behaviors are recognized and recorded by rule-based camera behavior analysis technology, and indentifying photo's semantic information and matching it with unsafe acts in our knowledge base by means of JHA (Job Hazard Analysis) and VSM (Vector Space Model). By this step, it realizes the recognition of behavioral risk and the collection of worker's behavior data. Thirdly, storing collected multi-source isomerous data(structured data and unstructured data) by HDFS in big data-based cloud platform. It is possible to realize behavioral risk visualization because recorded images of unsafe behavior are marked by complete semantic information, what's more, it lay the foundation for future correction of worker's behavior.
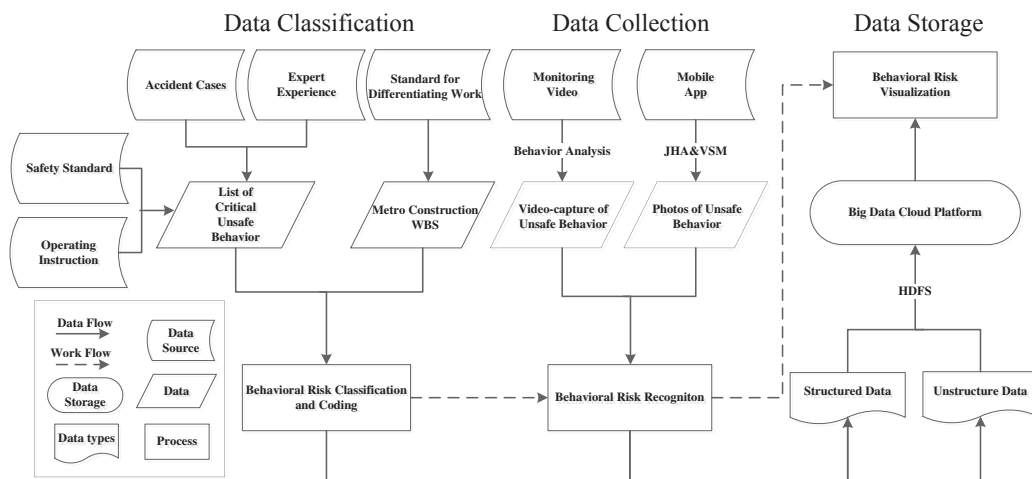

Fig. 1. An overview of data classification, collection and storage in the framework of big data-based behavior observation

2.1. Classification and coding of unsafe behavior data in metro construction

This research classifies unsafe behavior in different types, considering China's actual situation and metro construction's specialty, and encodes them by combing with subway construction work breakdown structure, finally develops the behavioral risk knowledge base of subway construction.

Firstly, organizing unsafe behavior list in four aspects: safety standards, operating instruction, accident cases and expert experience. This paper uses several standards as references to list partial unsafe behavior in metro