Industrial Security Solution for Virtual Reality

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IEEE INTERNET OF THINGS JOURNAL, VOL. 8, NO. 8, APRIL 15, 2021 6553

Abstract—In order to protect industrial safety, improve the operation stability of the industrial control system, conduct the response measures for network environment attacked by the external world, and realize simulation in virtual reality environment, in this study, class and sample weighted C-support vector machine (CSWC-SVM) algorithm is first proposed using SVM. Then, the intrusion detection model of industrial control network is built based on the CSWC-SVM algorithm. Finally, KDD CUP 1999 data are introduced to carry out simulation experiments on the algorithm model constructed in this study in the virtual reality simulation environment. The results show the penalty factor of the polynomial kernel function, radial basis kernel function, and sigmoid kernel function is 10^4, the average number of support vectors is 42, 40, and 75, respectively: the average training time are about 0.0, 24.0, 0.0, 24.0, and 7.0 s, respectively; the average test time is about 5.01 s, respectively; the average recognition accuracy is about 28.5%, 30.5%, and 30.7%, respectively; the accuracy of the CSWC-SVM algorithm in different sample sizes (0000–0001) can be kept above 90%. The operation error rate of the CSWC-SVM algorithm is lower than that of C-SVM, C-SVM, and RS-SVM algorithms under different validation data sets. After dimension reduction, the classification accuracy of the CSWC-SVM algorithm is higher than that of C-SVM and WC-SVM algorithms. The weight value increases from 0 to 500, and the number of model errors on 1000, 3000, and 5000 pieces of data decreases significantly. When the weight value is 500, the number of errors drops to 0, and the classification accuracy reaches 100%. In a word, the CSWC-SVM algorithm constructed in this study performs well in response to the attack of the industrial control system in the virtual reality simulation environment, which provides practical significance for the application of virtual reality in industrial monitoring.

Index Terms—Class and sample weighted C-support vector machine (CSWC-SVM) algorithm, industrial control system, network intrusion detection, support vector machine, virtual reality.

I. INTRODUCTION

THE industrial control system is the basic core facility in the industrial field, which has been widely applied in the fields of petrochemical industry, power transmission, transportation, and so on. With the development of information technology, the industrial control system is constantly connected with the Internet and the Internet of Things, and it gradually becomes an open structural system. This open structure makes the system face security threats and constantly suffer from external invasion attacks, which seriously affects the stable operation of the industrial control system and reduces the industrial production efficiency [5], [3]. Therefore, it is necessary to adopt relevant technology to protect the industrial control system from attack. Traditional security protection technologies, such as vulnerability patches, firewalls, and antivirus software, are relatively mature, but they do not use industrial control system [4]. According to the characteristics of the industrial control system, the appropriate protection strategy should be adopted.

The intrusion detection technology is an active defense technology, which can monitor the communication behavior of the system and capture the interception attack information in real time. It is currently a relatively efficient security protection technology [2]. Among the commonly used intrusion detection methods, a large amount of data needs to be calculated and the real-time performance is poor, which cannot meet the detection requirements. Therefore, a simple and more efficient detection algorithm is needed [6]. SVM is a new tool to solve machine learning problems in data mining using optimization method. It is a machine learning method to seek a global optimal solution. Based on the principle of minimizing structural risk, it can perfectly solve the recognition problem of the small sample, nonlinear, and high dimension problem, and has the advantages of strong generalization ability and high precision [7]. Kamen Ia et al. [8] proposed an efficient adaptive intrusion detection technology using SVM. The principal gravity search algorithm can effectively improve the performance of traditional algorithms in terms of the intrusion detection rate and positive false rate. Therefore, intrusion detection data have the characteristics of high dimension and nonlinearity, and SVM can be applied to it. However, the