APPLICATION OF REMOTE INSTALLATION AND MEASUREMENT SMART VEHICLE IN ACCELERATOR*

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Abstract

The installation, alignment measurement and vibration monitoring of the accelerator equipment are cumbersome. In order to reduce the work intensity and exposure time of personnel, this paper has developed a smart vehicle that can automatically walk and automatically adjust the horizontal in the accelerator or beam line area. The smart vehicle can move forwards, sideways, oblique lines, rotations and combinations, and can automatically adjust the level according to different terrains. The auto-levelling accuracy is better than 0.001 degrees. By installing vibration measuring equipment or collimating equipment on the vehicle platform, vibration testing and collimation measurement of the equipment in the accelerator or beamline device can be performed.

INTRODUCTION

The remote measurement smart vehicle (Figure 1) is mainly composed of a body, McNamee wheels movement module, a lifting module, a parallel six-degree-of-freedom platform [1, 2], an electrical module and a control panel. The main body of the vehicle is constructed of high-strength hard aluminium alloy and aluminium profiles. The car is equipped with four sets of McNamee wheels motion platform, which can realize forward, horizontal, oblique, and rotation and combination sports. Lifting module maximum load is greater than 2000N, can achieve 0-500mm range of lifting movement. The six-degree-of-freedom platform mainly realizes the self-levelling and angle adjustment functions required for the vibration measuring equipment and the alignment equipment. Two 24V power interfaces are reserved for the walking platform to provide power to other on-board devices.

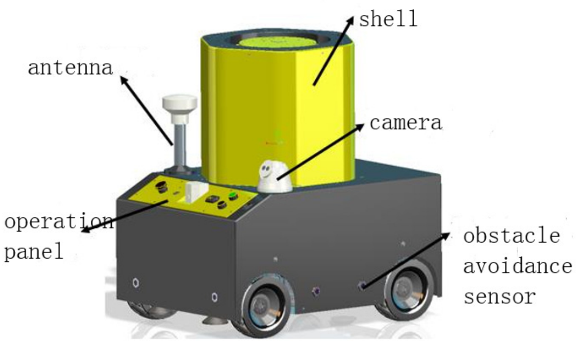

Figure 1: Structure of the smart vehicle.

SMART VEHICLE PERFORMANCE TEST

Smart vehicle walking tests mainly include automatic walking and manual walking. The vehicle and the upper computer control system communicate data through the wireless network. The automatic walking mainly realizes the straight running, left-turning, right-turning and stopping of the smart vehicle through the two-dimensional code identification and positioning technology.The vehicle walking movement information is recorded on each two-dimensional code. The smart vehicle scans the two-dimensional code to obtain the movement. The scanning range is φ200mm. Before detecting the action information of the next two-dimensional code, the smart vehicle will continue to maintain the previous command. Manual walking indicates the forward and backward rotation of the smart vehicle through the control button. The infrared obstacle avoidance sensor and image acquisition system are arranged around the whole vehicle, and the environment in front of the vehicle can be obtained in the upper computer. Figure 2 shows the smart vehicle measuring in a simulated accelerator tunnel. Figure 3 shows a two-dimensional code tracking test of the smart vehicle.

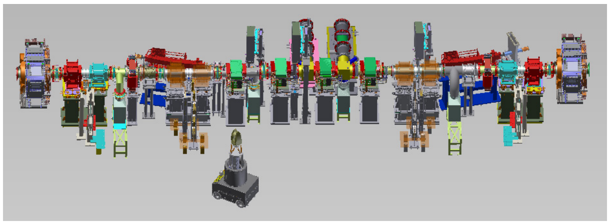

Figure 2: The smart vehicle measuring in a simulation accelerator tunnel.

SMART VEHICLE AUTO-LEVELLING TEST

When the vehicle is in place, in order to meet the level requirement of the alignment device, the level of the moving platform at the top of the smart vehicle needs to be adjusted [3]. According to the level requirement of the alignment measurement, the level of the platform needs to be better than 0.001°. After measurement, the three directions of the XYZ range of rotary angle travel are ±10° and the travel range is ±29mm. Figure 4 shows the position error curve of open-loop control of the horizontal adjustment mechanism of the smart vehicle. The open-loop position error is within 1mm. Figure 5 shows the attitude error curve of the open-loop control mechanism of the

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horizontal adjustment mechanism of the smart vehicle. The accuracy is within 0.04°. After closed-loop control, the positioning accuracy of the horizontal adjustment mechanism of the carriage is shown in Table 1, and the horizontal angle accuracy is better than 0.00086°.

Figure 3: The two-dimensional code tracking test.

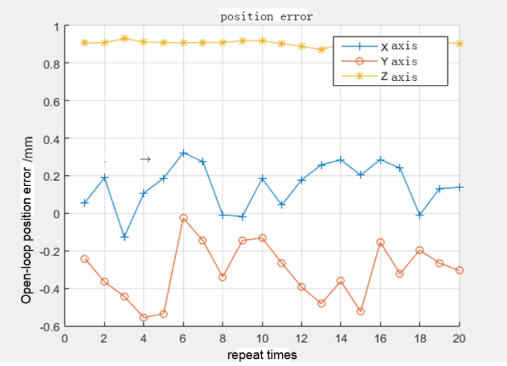


Figure 4: The open-loop position error curve.

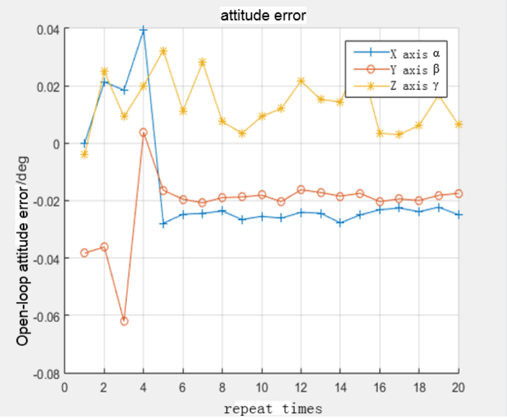


Figure 5: The open-loop attitude error curve.

Table 1: Closed-Loop Accuracy of the Horizontal

Axis	X	Y	Z	α	β	γ
Close-loop accuracy	0.004 mm	0.005 mm	0.001 mm	0.00025 deg	0.00043 deg	0.00086 deg

VIBRATION MONITORING TEST

The vehicle is equipped with a vibration monitoring system to detect the vibration of the equipment. As shown in Figure 6, the vibration monitoring system can be fixed on the smart vehicle, and the height of the vibration system can be changed by a lifting mechanism. By adjusting the attitude of the parallel 6-DOF platform, a swing of ±10 degrees can be achieved, thereby increasing the testing range. At the front of the vehicle, there is a video monitor. Through the video monitor, the position of the vibration monitoring lens can be clearly seen. The smart vehicle simulates a vibration test in the laboratory. During the test, in order to obtain a better imaging effect, the smart vehicle needs a higher positioning accuracy or a more convenient adjustment operation. After testing, within the range of ±200mm of the fixed position, multiple sets of different vibration data were tested. The results show that the camera can obtain better imaging results and measure the vibration data. Figure 7 shows the target images captured by the vibration monitoring system. Figure 8 shows the data collected by the vibration monitoring system.

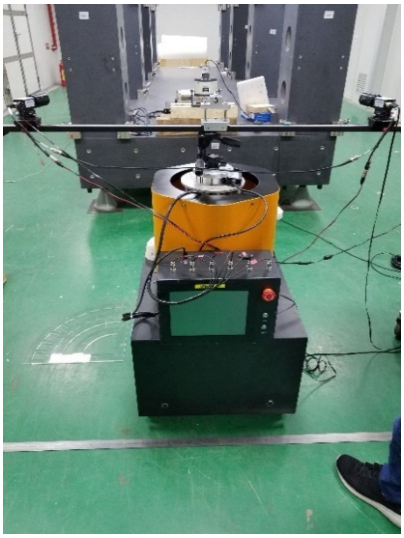


Figure 6: Vibration monitoring equipment test on the smart vehicle.

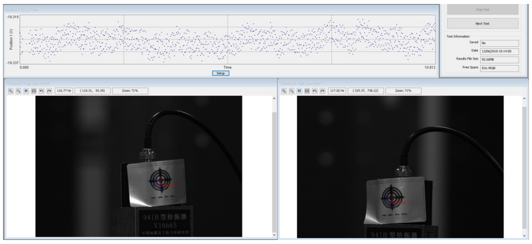
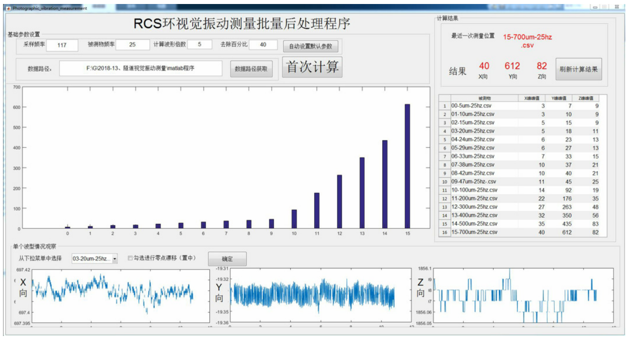


Figure 7: Vibration monitoring acquisition images.

PHOTOGRAPHIC ALIGNMENT MEASUREMENT

When the smart vehicle is equipped with an alignment device, the alignment of the device can be measured. Figure 9 shows an alignment measurement test by the smart vehicle equipped with an alignment device at the target station of the Chinese Spallation Neutron Source. The vehicle can also be equipped with a radiation dose detection device to monitor the radiation dose in the tunnel or carry a robot to perform specific operations.



RCS环视觉振动测量批量后处理程序

基础参数设置

采样频率 117

被测物频率 25

计算波形倍数 5

去除百分比 40

数据路径： F:\G\2018-13、隧道视觉振动测量\matlab程序

计算结果

最近一次测量位置 15-700um-25hz.csv

结果 40 X向 612 Y向 82 Z向

	被测物	X峰峰值	Y峰峰值	Z峰峰值
1	00-5um-25hz.csv	3	7	9
2	01-10um-25hz.csv	3	10	9
3	02-15um-25hz.csv	5	15	9
4	03-20um-25hz.csv	5	18	11
5	04-24um-25hz.csv	6	23	13
6	05-29um-25hz.csv	6	27	13
7	06-33um-25hz.csv	7	33	15
8	07-38um-25hz.csv	10	37	21
9	08-42um-25hz.csv	10	40	21
10	09-47um-25hz-.csv	11	45	25
11	10-100um-25hz.csv	14	92	19
12	11-200um-25hz.csv	22	176	35
13	12-300um-25hz.csv	27	263	48
14	13-400um-25hz.csv	32	350	56
15	14-500um-25hz.csv	35	435	83
16	15-700um-25hz.csv	40	612	82

单个波型情况观察

从下拉菜单中选择 03-20um-25hz...

☐ 勾选进行零点漂移（置中）

Figure 8: Vibration monitoring acquisition data.

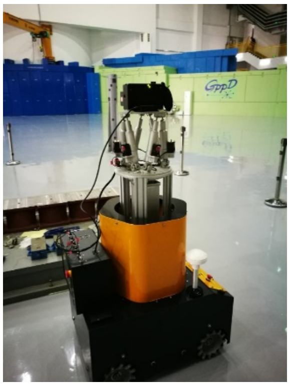


Figure 9: Photographic alignment measurement test.

CONCLUSION

The remote installation and measurement smart vehicle can carry various test devices to complete various test work in the accelerator, which can effectively reduce the labour time and labour intensity of the operator, and at the same time reduce the radiation time for the operator, and can be promoted in various accelerator devices.

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