







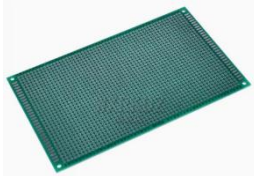







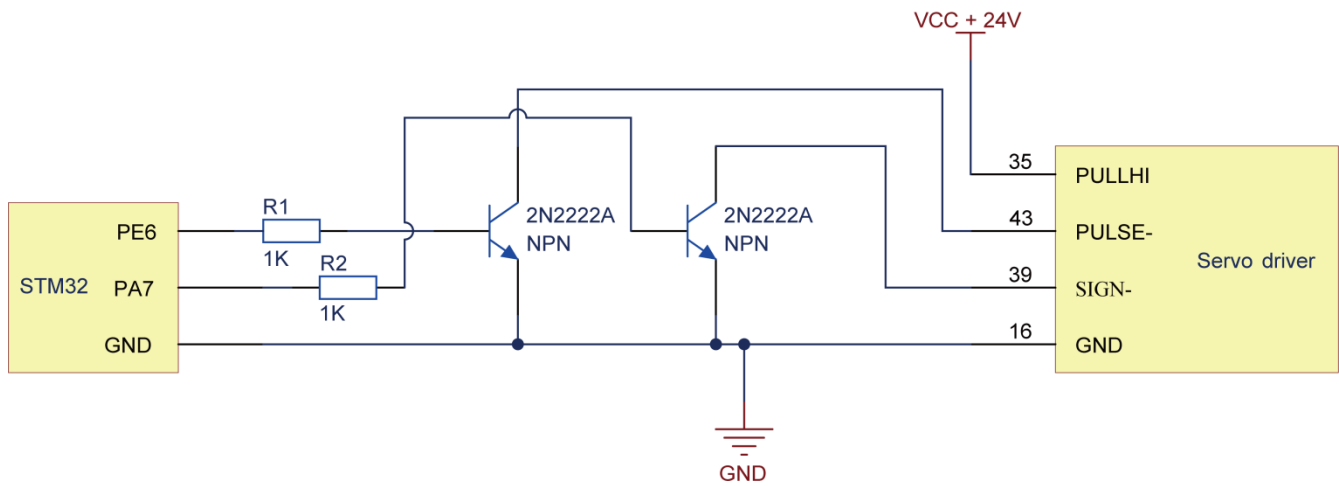


**Table. S1** Hardware list

Hardware Module			
Item(model)	Image	Parameter	Link
Computer		Precision 5820 Tower Inter(R) Xeon(R) W-2155 CPU NVIDIA GeForce RTX 2080Ti	<a href="https://www.dell.com/zh-cn/shop/">https://www.dell.com/zh-cn/shop/</a>
Stm32		STM32F103ZET6 72 MHz clock	<a href="https://item.taobao.com/item.htm?spm=a1z0k.7386009.1997985097.d4918993.46cf37de6uNgrP&amp;id=523092580242&amp;_u=t2dmg8j26111">https://item.taobao.com/item.htm?spm=a1z0k.7386009.1997985097.d4918993.46cf37de6uNgrP&amp;id=523092580242&amp;_u=t2dmg8j26111</a>
Camera		HF868SS Pixel Size 3um*3um 480P:120 fps	<a href="https://detail.tmall.com/item.htm?_u=t2dmg8j26111&amp;id=627225947424&amp;spm=a1z0k.7386009.1997985097.d4918993.46cf37de6uNgrP">https://detail.tmall.com/item.htm?_u=t2dmg8j26111&amp;id=627225947424&amp;spm=a1z0k.7386009.1997985097.d4918993.46cf37de6uNgrP</a>
Servo Motor Driver		0.1kw-5.5kw SVPWM 220VAC+10% ~-15% RS-485	<a href="http://www.fereme.cn.tonbao.com/">http://www.fereme.cn.tonbao.com/</a>
Slide rail		Length: 1000 mm Width: 1000 mm	<a href="https://item.taobao.com/item.htm?spm=a1z0k.7386009.1997985097.d4918993.46cf37de6uNgrP&amp;id=629115224689&amp;_u=t2dmg8j26111">https://item.taobao.com/item.htm?spm=a1z0k.7386009.1997985097.d4918993.46cf37de6uNgrP&amp;id=629115224689&amp;_u=t2dmg8j26111</a>
Square Magnetic Block		Length: 100 mm Width: 50 mm Thickness: 20 mm	<a href="https://item.taobao.com/item.htm?spm=a1z0k.7386009.1997985097.d4918993.46cf37de6uNgrP&amp;id=584042996591&amp;_u=t2dmg8j26111">https://item.taobao.com/item.htm?spm=a1z0k.7386009.1997985097.d4918993.46cf37de6uNgrP&amp;id=584042996591&amp;_u=t2dmg8j26111</a>

Round magnetic block		Diameter 40 mm thickness 10 mm	<a href="https://detail.tmall.com/item.htm?id=619864317122">https://detail.tmall.com/item.htm?id=619864317122</a>
Regulated power supply		Output voltage: 0-30 V Output current: 0-3 A	<a href="https://item.taobao.com/item.htm?spm=a1z0k.7386009.1997985097.d4918993.46cf37de6uNgrP&amp;id=610465415897&amp;_u=t2dmg8j26111">https://item.taobao.com/item.htm?spm=a1z0k.7386009.1997985097.d4918993.46cf37de6uNgrP&amp;id=610465415897&amp;_u=t2dmg8j26111</a>
circuit board		Length: 60 mm Width: 40 mm Hole spacing: 2.54 mm	<a href="https://detail.tmall.com/item.htm?abbucket=0&amp;id=619035415749&amp;ns=1&amp;skuId=4368959501684&amp;spm=a21n57.1.0.0.7237523chCxvsC">https://detail.tmall.com/item.htm?abbucket=0&amp;id=619035415749&amp;ns=1&amp;skuId=4368959501684&amp;spm=a21n57.1.0.0.7237523chCxvsC</a>
Square acrylic plate		Length: 800 mm Width: 800 mm Thickness: 10 mm	<a href="https://detail.tmall.com/item.htm?_u=t2dmg8j26111&amp;id=45653259177&amp;spm=a1z0k.7386009.1997985097.d4918993.46cf37de6uNgrP">https://detail.tmall.com/item.htm?_u=t2dmg8j26111&amp;id=45653259177&amp;spm=a1z0k.7386009.1997985097.d4918993.46cf37de6uNgrP</a>
Acrylic cylinder		Diameter 800 mm, height 300 mm, thickness 8 mm	<a href="https://item.taobao.com/item.htm?spm=a1z0k.7386009.0.0.46cf37de6uNgrP&amp;id=668894324208&amp;_u=t2dmg8j26111">https://item.taobao.com/item.htm?spm=a1z0k.7386009.0.0.46cf37de6uNgrP&amp;id=668894324208&amp;_u=t2dmg8j26111</a>
Anti-vibration table		Length 1500 mm Width 1500 mm Height 750 mm	<a href="https://item.taobao.com/item.htm?spm=a1z0k.7386009.1997985097.d4918993.46cf37de6uNgrP&amp;id=19140891812&amp;_u=t2dmg8j26111">https://item.taobao.com/item.htm?spm=a1z0k.7386009.1997985097.d4918993.46cf37de6uNgrP&amp;id=19140891812&amp;_u=t2dmg8j26111</a>

Platform support frame		OB3030 Length 1600 mm height 900 mm width 800 mm	<a href="https://item.taobao.com/item.htm?spm=a1z0k.7386009.1997985097.d4918993.46cf37de6uNgrP&amp;id=598799357725&amp;_u=t2dmg8j26111">https://item.taobao.com/item.htm?spm=a1z0k.7386009.1997985097.d4918993.46cf37de6uNgrP&amp;id=598799357725&amp;_u=t2dmg8j26111</a>
Camera support frame		Maximum width 3300 mm, maximum height 2600 mm	<a href="https://detail.tmall.com/item.htm?_u=t2dmg8j26111&amp;id=653440514110&amp;spm=a1z0k.7386009.1997985097.d4918993.46cf37de6uNgrP&amp;skuId=4710466984766">https://detail.tmall.com/item.htm?_u=t2dmg8j26111&amp;id=653440514110&amp;spm=a1z0k.7386009.1997985097.d4918993.46cf37de6uNgrP&amp;skuId=4710466984766</a>
Circuit Components			
DuPont Line		/	<a href="https://detail.tmall.com/item.htm?ali_refid=a3_430582_1006:1109983619:N:MsF9mE9KLTC2IibWJh+K1A==:c2aeb01b6bfca0fdcd9eb0571b55a201&amp;ali_trackid=1_c2aeb01b6bfca0fdcd9eb0571b55a201&amp;id=41254478179&amp;spm=a21n57.1.0.0&amp;sku_properties=122216547:20213">https://detail.tmall.com/item.htm?ali_refid=a3_430582_1006:1109983619:N:MsF9mE9KLTC2IibWJh+K1A==:c2aeb01b6bfca0fdcd9eb0571b55a201&amp;ali_trackid=1_c2aeb01b6bfca0fdcd9eb0571b55a201&amp;id=41254478179&amp;spm=a21n57.1.0.0&amp;sku_properties=122216547:20213</a>
2N2222A		NPN	<a href="https://detail.tmall.com/item.htm?_u=t2dmg8j26111&amp;id=602012446142&amp;spm=a1z0k.7385961.0.0.3dd337deMz7y0R&amp;skuId=4209941168719">https://detail.tmall.com/item.htm?_u=t2dmg8j26111&amp;id=602012446142&amp;spm=a1z0k.7385961.0.0.3dd337deMz7y0R&amp;skuId=4209941168719</a>



**Fig. S9** Signal adaptation circuit

Ports PE6 and PE7 in the STM32 give direction and speed signal, respectively, which are passed through an amplifier circuit to ports 43 and 39 of the servo motor controller.