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Research on Arduino Single Chip Mechanical Experiment Device

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Abstract

The mechanical experiment device based on Arduino microcomputer solves the error of measuring the friction, gravity and the surface friction factor and the calculation error of the traditional mechanical experiment teaching. And the problem of long measurement process time, low accuracy and low measurement efficiency.

Keywords

Physics Experimental Equipment Improve; Physics Teaching; Based on Arduino MCU.

1. Theory

Based on Arduino single chip mechanical experiment device for the traditional physical mechanics experiment and teaching error and teaching status made gaps and improvement, can more convenient and accurate experimental teaching demonstration and student experimental operation, measure friction, gravity and object surface friction factor three physical data, and can through its own function more convenient reading and record data, complete the experimental teaching and learning task. The mechanical experimental unit based on Arduino chip has five units: core control unit, sensor unit, power unit, display unit and wireless transmission unit. The overall control of the whole instrument is achieved by compiling the A rduino MCU, and the inner rotor of the mechanical experimental device based on Arduino is driven to do stable uniform speed circular motion, driving and maintaining the object to do uniform speed linear motion through fine lines. The single chip machine controls the display unit, which shows the display directly at the stability value, the friction force, the dynamic friction factor size, and is able to be accurate to the three decimal places. The exhibits are integrated packaging appearance using laser cutting technology, the design and cutting of acrylic plates that meet the modern teaching requirements and the assembly of components, easy for operation, carrying and demonstration.

2. Introduction of technical route and improvement scheme

2.1 Technical route

Newton tonian third law applied to the friction is to keep the object straight at a constant speed. The meter drives the steering machine inside the measuring instrument through the Arduino single chip machine, so that the rotating wheel connected to the steering machine can rotate at a uniform speed, and is connected to the object through fine lines, to ensure the uniform movement of the object and reach the measurement standard. Secondly, the pull sensor and gravity sensor are added inside the meter, which enables it to directly display the measurement value of gravity size and pull force through the display screen.

The internal steering machine of friction measurement can drive the rotating wheel through the compilation of Arduino. Compared with the traditional manual pull spring force meter, the prerequisite for friction measurement by Newton's third law;

The pull sensor can directly measure the size of the pull, directly display the pull data through the display, the gravity sensor can directly measure the gravity, directly display the gravity data through the display, avoiding the error caused by readings in traditional experiments. The resulting tensile

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force and gravity data are transmitted to the single-chip machine via the electrical signal to quickly calculate the corresponding friction coefficient.

In order to better connect the pull sensor, the steering machine and the object, we adopted the application of the fixed pulley theorem, the pull sensor as a fixed pulley, connect the object to the steering wheel through thin wire, compile the pull sensor through the arduino single chip, and finally makes the pull value of the display output equal to half of the actual sensor measurement, that is, the pull force of the object, that is, the friction value of the object.

In terms of static accuracy and dynamic balance of data acquisition, the error reduces the incoming signal and ensures high resolution. Ensure that the accuracy of the converter matches the accuracy of the measured device. We chose the H X711, to improve the performance and reliability of the whole machine.

The S SD1306128 X 36 LCD plate was used. The chip is designed for a co-cathode O LED panel, embedded in a contrast controller that displays R AM, crystal vibration, and reduces the consumption of external components.The measurement instrument is very appropriate.

2.2 Introduction of the improvement scheme

3.2.1. Control unit

The control unit is the main unit of friction measurement, which uses the arduino single-chip machine as the core unit to implement the program control. As the core part of the friction measurement, the arduino microchip machine achieves the overall control of the whole instrument, and drives the internal steering machine, tension sensor and display screen to obtain the measurement data. In order to enable the display module controlled by the core control unit to accurately obtain the data of the friction force of the object, that is, the tension force at the other end of the fine line connected to the object, the data information of the measured tensile force is stored therein. When the control unit detects the tensile size information at the corresponding port, the corresponding data conversion method matches the corresponding channel of the docking station and transforms the corresponding data. Each module is independent from each other, and has a unified interface electrical connection and mechanical connection structure to form a unified standardized module component.

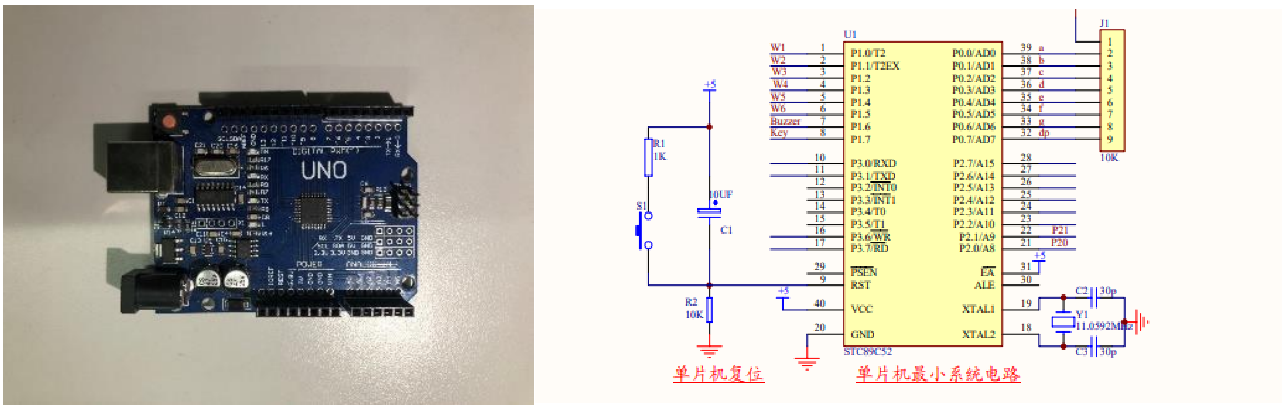

Figure 1. A rduino single-chip machine and application circuit diagram

3.2.2. Power unit

The power unit is mainly applied by the steering machine. The main purpose is to control the internal rotor wheel, so that it rotates at a uniform speed, so as to drive the object to do a uniform speed straight line movement. The steering machine is controlled by connecting the lead line to the arduino plate to rotate at a constant speed of 360 degrees. And through the laser printing of the acrylic board, design and print the wheel with grooves in the middle, embedded on the steering wheel, drive the wheel to turn at a constant speed. In addition, the fine line winding, so that the fine line drives the object to do a uniform speed straight line movement. It realizes the design of driving the steering

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wheel through the steering wheel, reduces the factors of internal error, ensures the precondition for the movement of the object at a constant speed, and makes the measurement results more accurate

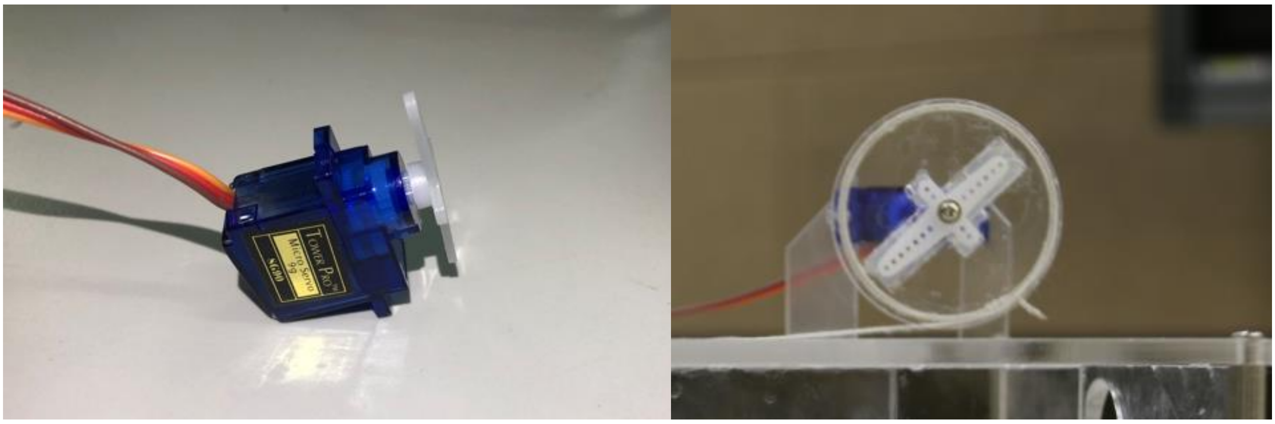

Figure 2. Power part main parts steering machine and acrylic printing wheel

3.2.3. Sensor unit

The sensor unit operates using tensile sensors and gravity sensors and is connected to the arduino board via the X H 711 converter, enabling the sensor to transform the physical signal into measurable Telecom Nooutput. Thus, the process of transforming the external force to the electric signal is completed. The advantages of tensile sensor are high accuracy, wide measurement range, long life, simple structure, good frequency sound characteristics, can work in harsh conditions, easy to achieve miniaturization, integration and diversification of variety.

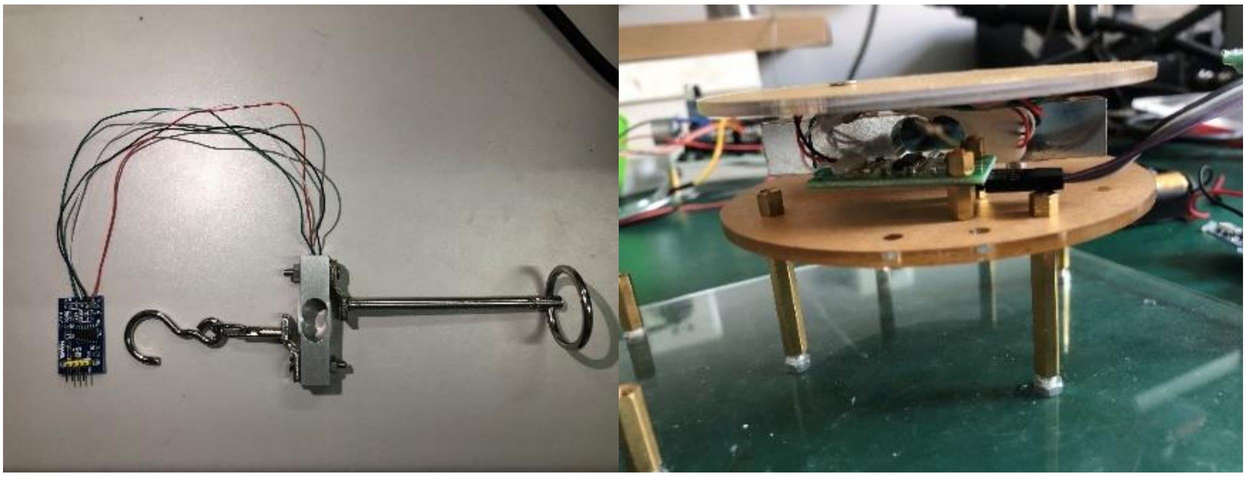

Figure 3. Pull sensor and gravity sensor

3.2.4. Display unit

The display unit uses an LCD screen to display the data, and the display screen is a widely used character-type LCD display module. Since the instrument itself is mainly achieved by applying the principle of two-force balance. Two-force equilibrium means that the object is in equilibrium under the action of two forces, and then the two forces are balanced with each other. This unit connects the display to the pull sensor and the arduino via the DuPont cable. Based on the display of the single chip machine, the single chip machine is compiled for the single chip. When the measured friction is stable, the instrument directly shows the size of the friction coefficient of the object through the core control unit and the sensor unit sensing the tensile force tension at one end of the fine line connecting the object and the instrument. The unit is designed to avoid errors caused by inaccurate spring force meter readings during the traditional measurement process.

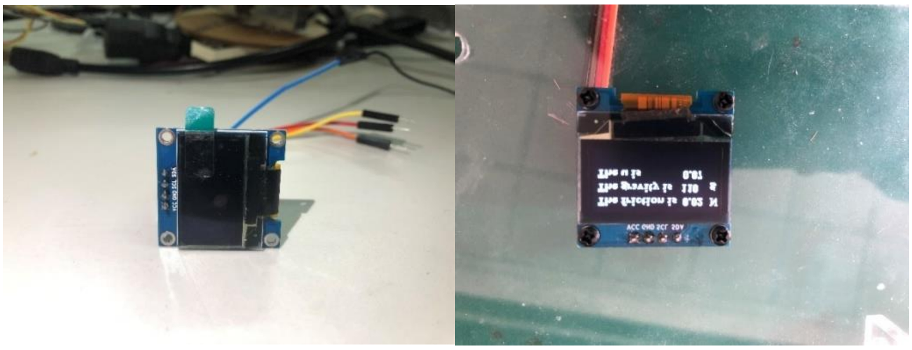

Figure 4. The Oled display screen

3.2.5. External package unit

We have put the exhibits in an integrated packaging, easy to carry, easy storage, more convenient to use. According to the traditional measurement experiments, the measurement precondition is that the tensile force and the sliding friction force are on the same level, and the line of action is on a straight line. Therefore, a lifting base is added to the bottom of the instrument to ensure that the object center of gravity is on the same level when measuring the sliding friction of different sizes of objects.

Since measuring the friction between two objects needs to be adjusted accordingly according to different objects, we adopt the replaceable base scheme to provide users with a variety of optional bottom plates to meet the measurement requirements under different conditions.

Now our product only measures the friction between some small objects in the laboratory, and the friction measurement itself is small, the bearing range of forces has great limitations, cannot be widely used for outdoor measurement, for the measurement between some large objects is not perfect enough. Later, we intend to further improve the instrument and increase the robustness of the instrument itself.

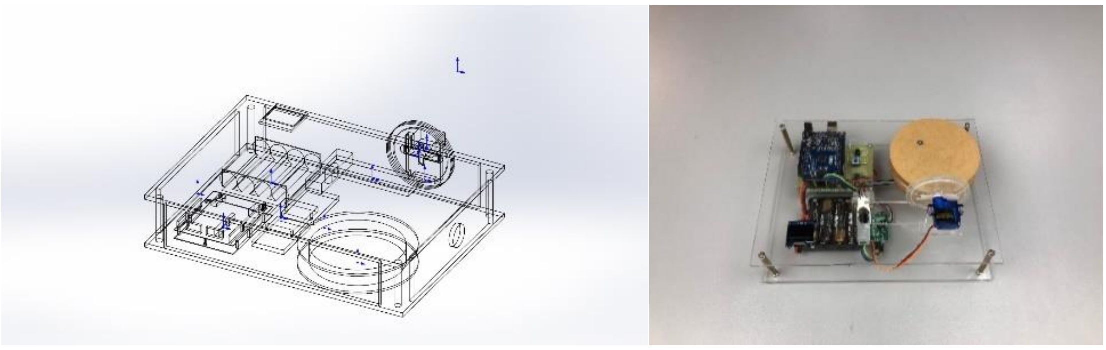

Figure 5. The 3D modeling diagram and the product physical diagram

3. Experimental practice

Use method of mechanical experimental device based on Arduino microchip machine:

Step 1, the user uses the friction measurement device for the first time, and the control terminal is supplied by the battery;

In Step 2, the user turns on the switch and places the measured object on the gravity sensor of the device itself, which reads and records the object weight;

Step 3, the user connects the fine line to the object, places the friction measurement device and object on the required measurement object, or on the surface of the sampling object, opens the switch, makes the steering machine drive the object to move straight line at uniform speed, the tension sensor detects the tension data in real time, transforms the physical signal into an electrical signal, to obtain the friction data;

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Step 4, the A rduino single-chip machine receives the object weight data and the friction data, and can calculate the friction system value of the two objects;

In Step 5, the user can read the data through the Oled display. The first row of data is the object gravity data, the second row of data is the friction size data of the object, and the third row of data is the data value of the object surface friction coefficient.

Step 6, turn off the switch and end the measurement.

Experimental measurement data of the mechanical experimental device based on the Arduino single-chip machine:

Table 1. Wood block-wood block

Materials	Number of experiments	(N)	(N)	f (N)		Relative error%	
Wood block-wood block	1	1.000	3.509	0.3003	0.3003	0.03%	0.3000
	2	1.002	3.502	0.3004	0.2998	0.02%	
	3	1.001	3.500	0.3001	0.3001	0.01%	
	4	1.000	3.503	0.3000	0.3000	0.00%	
	5	1.001	3.500	0.3001	0.3001	0.01%	
	6	1.000	3.509	0.3003	0.3003	0.03%	
	7	1.002	3.502	0.3004	0.2999	0.02%	

Table 2. Metal-Wood Block

Materials	Number of experiments	(N)	(N)	f (N)		Relative error%	
Metal-Wood Block	1	1.000	3.506	0.2002	0.2002	0.03%	0.2000
	2	1.002	3.507	0.1998	0.1996	0.04%	
	3	1.001	3.503	0.2008	0.2008	0.08%	
	4	1.000	3.501	0.2010	0.2010	0.10%	
	5	1.001	3.500	0.2001	0.2001	0.01%	
	6	1.000	3.509	0.2003	0.2003	0.03%	
	7	1.002	3.504	0.1998	0.1989	0.02%	

Table 3. Just-just

Materials	Number of experiments	(N)	(N)	f (N)		Relative error%	
Just-just	1	4.000	2.002	1.004	0.2504	0.04%	0.2500
	2	4.002	1.9998	1.004	0.2494	0.06%	
	3	4.001	2.008	1.003	0.2498	0.02%	
	4	4.000	2.010	1.004	0.2513	0.13%	
	5	4.001	2.001	1.003	0.2512	0.12%	
	6	4.000	2.003	1.004	0.2498	0.02%	
	7	4.002	1.9998	1.004	0.2504	0.04%	

Table 4. Rubber tires (model) -pavement (dry)

Materials	Number of experiments	(N)	(N)	f (N)		Relative error%	
Rubber tires (model) - - pavement (dry)	1	3.000		2.191	0.7307	0.07%	0.7300
	2	3.002		2.193	0.7303	0.03%	
	3	3.001		2.182	0.7289	0.11%	
	4	3.000		2.191	0.7297	0.03%	
	5	3.001		2.193	0.7307	0.07%	
	6	3.000		2.191	0.7303	0.03%	
	7	3.002		2.194	0.7306	0.06%	

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4. Conclusions

As the core part of the friction measurement, the arduino single-chip machine achieves the overall control of the whole instrument, driving the internal steering machine, pull sensor, gravity sensor and display screen to obtain the measurement data. Maxgreatly reduces the error of the traditional friction and friction coefficient.

The AD converter is selected to reduce the raw error outgoing of the incoming signal and to ensure high resolution. Ensure that the accuracy of the converter matches the accuracy of the measured device. We chose to choose the HX711, to improve the performance and reliability of the whole machine.

In terms of the display and processing of extracting information data, the liquid crystal plate that we now adopt is: SSD1306128 X 36. The chip is designed for a co-cathode OLED panel, embedded in a contrast controller that displays RAM, crystal vibration, and reduces the consumption of external components. The measurement instrument is very appropriate.

The spatial structure node technology, for the stability and appearance design of the device, is repeatedly optimized and measured, and finally adopts three layers of stacking, which greatly ensures the stability of the object and the device, but also ensures the cleanliness and beauty of the instrument.

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