Filament Scale

1   Introduction

This system is designed to give a continuous display of how much filament is left on the spool. It does this by knowing the weight of the empty spool and subtracting this from the total weight that is measured. The empty spool weight can be determined by using any of the following methods:

1. Weighing on a scale and entering the value manually.
2. Weighing an empty spool on this system and entering the value manually.
3. Weighing a full spool on a scale and subtracting the filament weight to give the spool weight which is then entered manually.
4. Weighing a full spool on this system with a known amount of filament, typically 1kg. Subtracting the filament weight from the total weight gives the spool weight which is then entered manually.

The system maintains a list of 100 spool settings that are easily selected.

The main display shows the following information.

- Remaining filament weight and approximate length[1]
- Usage rate in grams/minute[2]
- Remaining time in hours:minutes[3]

2   Hardware

2.1   3D Printed Parts

The STL files for the needed parts can be found here: https://www.thingiverse.com/thing:4723557

The mount has been designed to attach to Creality type filament spool holders. It will work with many others as well. Special mounts may be designed in the future if the need arises. The mount is designed so it can be rotated for the proper scale measuring direction, vertical, horizontal, or anything in between.

2.2   Other Parts Needed

The main part used is a TTGO ESP32 T-Display component. It is wired with a rotary push button and the HX711 loadcell amplifier. I have created a PCB that can be purchased that holds all the parts, but it is also easy to hand wire all the components. The wiring diagram can be found on the github site.

- TTGO ESP32 T-Display. https://www.amazon.com/TTGO-T-Display-Bluetooth-Development-Arduino/dp/B07XQ5G279/ref=sr_1_1_sspa?crid=DFS8HSCA4CFS&dchild=1&keywords=ttgo+t-

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[1] The length use a value that can modified in the menu system. The default value of 333.12 is an average for normal filaments. Some filaments may weigh more or less and this number can be changed to make the calculation more accurate.

[2] The accuracy of this depends on how accurately the scale has been calibrated and how good the loadcell is.

[3] This accuracy also depends on the scale calibration. Testing has not been done yet to determine how accurate this calculation is.

display+esp32&qid=1612330662&s=electronics&sprefix=ttgo+t%2Celectronics%2C222&sr=1-1-spons&psc=1&spLa=ZW5jcnlwdGVkUXVhbGlmaWVyPUEzMFZSSEZUQUc0SUszJmVuY3J5cHRlZElkPUEwMzM4NzM0MVo0SzIzSllxM1BFVSZlbmNyeXB0ZWRBZElkPUEwMjI2ODQ2Skc1RVlJSE44SkJXJndpZGdldE5hbWU9c3BfYXRmJmFjdGlvbj1jbGlja1JlZGlyZWN0JmRvTm90TG9nQ2xpY2s9dHJ1ZQ==

- 5kg loadcell with HX711 amplifier.
  https://www.amazon.com/gp/product/B08KRWY43Y/ref=ppx_yo_dt_b_asin_title_o05_s00?ie=UTF8&psc=1
- Rotary push button switch.
  https://www.amazon.com/gp/product/B07DM2YMT4/ref=ppx_yo_dt_b_search_asin_title?ie=UTF8&psc=1
- 5V power supply, USB works fine.
- 2- 42x20x12 mm ball bearings. These are commonly used in snow mobiles and are inexpensive.
  https://www.amazon.com/gp/product/B075QHL18L/ref=ppx_yo_dt_b_asin_title_o00_s01?ie=UTF8&psc=1

I supplied Amazon links, but most parts are readily available from other sources.

3 Software

The program source files are available at https://github.com/MartinNohr/FilamentScale .

3.1 Development Environment

I used Microsoft Visual Studio with the Visual Micro add-in. However, it is not required, the code should compile just fine using the Arduino IDE. Microsoft Visual Code should also work.

3.2 Libraries

The following software libraries are used.

- Bodmer TFT-eSPI for the display, configured for the TTGO T-Display
- HX711_ADC Arduino library for HX711 Scale by Olav Kallhovd
- EEPROM

4 The Main Screen

After booting the main screen of the system displays the following lines.

- A bar showing the % of the remaining filament based on the full size which can be set in the menus. There is only one value that defaults to 1000 grams. In the future this value might be stored with each spool number so that different spools size can be accommodated.
- The active spool number and the % left.
- The remaining weight in grams.
- The remaining length in meters.
- If the usage rate over time is not zero, the rate in grams/minute will be displayed.
- If the rate is not zero the remaining filament time will also be displayed in hours:minutes.

5   Menus

The menu system for setting values is entered by a long press of the push button. The dial is then rotated to move to different selections. Clicking the button selects the current choice. The current selection is indicated with a '*' at the front of the line. A '+' indicates that the choice switches to a new submenu. A '-'returns to the previous menu. A long press can also be used to immediately return to the main screen.

5.1   Main Menu

5.1.1   Main Screen

Closes the menu system and returns to the main screen.

5.1.2   Spool Settings

5.1.2.1   Previous Menu

Returns to the main menu.

5.1.2.2   Active Spool

This is used to select the currently active spool number. Different spool numbers allow for different spool weights. There is a limit of 100, which should be adequate. The active spool number is used by the main screen and by many of the following commands.

5.1.2.3   Spool Wt From Full

This command will ask for a full spool to be loaded. It will also ask for the weight of the filament. Using the weight of the spool and the entered weight the empty spool weight can be calculated by a simple subtraction. Remember to save the settings.

5.1.2.4   Weigh Empty Spool

This command will weigh an attached empty spool and use that weight directly. Remember to save the settings.

5.1.2.5   Empty Spool Wt

This command shows the spool weight and allows a new value to be manually entered.

5.1.2.6   Full Spool Weight

This command allows the filament weight for a full spool, typically 1kg, to be entered. This value is used on the main screen to calculate the % filament remaining on the spool.

5.1.2.7   Save Settings

Use this command to save the settings to the EEPROM so they will be loaded when the system is booted. It should be used any time any values are changed.

5.1.3   Scale Settings

5.1.3.1   Previous Menu

This returns to the previous menu.

5.1.3.2   Tare (reset zero)

This will ask for the spool to be removed so that the scale zero point can be set. For the best accuracy the spool nut should be attached in the same position as when a spool is on the scale.

5.1.3.3   Calibrate Weight

This procedure is used to calibrate the scale. It will first be tare'd to get the correct zero point. It will then ask for a spool of a given weight. This weight should be measured on another scale and the value in grams is entered when prompted. Make sure that the spool nut is always screwed onto the proper position. The settings should be saved or they will be lost on reboot. See the "Save Settings" command.

5.1.3.4   Weight to Length

This number is used to calculate the length from the weight. It defaults to 333.12 but may be changed for different filaments. It is the number of mm/gram.

5.1.3.5   Save Settings

This command will store the important settings in EEPROM where they are loaded from at boot time. The following settings are stored.

- Scale calibration value
- Tare offset
- Active spool number
- Spool weight array

5.1.4   Reboot System

This command will restart the system in case you think it has gone insane.