System Design of Model Rocket Launcher Multi-pose Detection Based on Kinetis K60

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ABSTRACT: In this paper, a model rocket attitude detection system based on K60 was promoted by choosing triaxial accelerometers and pressure sensors. It mainly includes the detection device, controller, display device, voice alarm module, etc. It can not only implement electronic launch platform, but also accurately obtain model rocket launch specific posture parameters, including the level angle of the launch platform and model rocket's center of gravity position. Besides, it can clear indicators of the rocket launch through a serial port graphical LCD display, and realize the Bluetooth module and dial the code switch to communicate using wireless data transceiver module short adjusting posture. Thus it is easier for man-machine interactive operation. If the test result is beyond the scope of booking reference angle, alarm module will automatically send alarm signal to remind operator manual adjustment, until the rocket launch properly.

KEYWORDS: K60; TFT visualization display; Posture adjustment; Wireless transmission

1. INTRODUCTION

In the field of the model rocket, launch platform is installed in horizontal condition ideally, so that the model rockets are in vertical state. As a control signal transmission medium, the working state of rocket launcher, which is normal or not, is directly associated with the possibility of achieving normal performance measures, and launching the rockets successfully. However, due to the influence of external factors such as installation error, the obliquity of the launch platform and horizontal direction always exist after installing. Besides, the model rocket may not be in the vertical position. As a result, the safety of rocket launch is seriously affected.

Currently, detecting the launch posture of model rocket usually adopts the plumb rule detection method. Firstly, draw the vertical direction with a plumb rule. And then, manual adjustment makes the model rocket in a vertical state. But this approach ignores the impact of rocket centroid on the launch trajectory. Once the rocket center of gravity to suddenly changes, even though the rocket on the launch platform is in vertical position, it's easy to have a real launch trajectory deviation due to the vertical path. On top of that, the sites of model rocket are commonly outdoor open area. Therefore, in the process of regulating, the wind, topography and other environmental factors can also cause interference on the launch of rocket model. It usually cause the launch failure and certain security threats. Thus, the technical personnel are urgently faced with a technical problem that is how to provide a kind of control system, which is used to adjust the composite rocket attitude and realize accurate access to specific posture parameters of rocket.

Considering the above factors, the system adopts the Kinetis K60 MCU family, consisting of damping launching platform, steel platform support frame, firing plate, step motor, TFT LCD display, alarm and a remote controller, etc. According to the dynamic scale value on the gauge plate as well as the rocket offset angle relative to the vertical direction displayed on the TFT LCD display, the system can achieve a model rocket attitude change in different directions by toggling through different switch on the remote control. When the center of gravity of a model rocket is not the center of projection, the alarm generates an alarm, and artificially changes the position of a model rocket according to the pressure value, in order to ensure that the focus is correct. The design of the system is simple, flexible and it is of strong human-computer interaction, environmental adaptability and high stability. So it can provide security protection for a model rocket launching. Some innovative ideas and application of this system can be used on the camera unit, the vertical take-off and landing aircraft, the vertical...
axis wind turbine and so on, to adjust the object in a horizontal or vertical state manually or automatically. Thus, it can be described as broad prospect.

1.1 System design

This system is a model rocket launch multi-gesture-control system, including detection devices, controllers and human-computer interaction module. The main module design is shown in Figure 1.

The entire workflow system is as follows:

(1) Detecting device consists of triaxial accelerometers and pressure sensors, combined with K60 microprocessor, with real-time monitoring parameters to achieve specific posture model rocket launch function. The operator can adjust the value of pre-owned reference angle range based on the current environment rocket launch, as a condition to judge the current environment.

(2) After receiving the attitude parameter from detection device, microcontroller calculates the current horizontal angle and the platform angle in the vertical direction. Besides, analyze the relationship between the current state and stored at launch rocket safety, and then issue the judgment result is shown in the display control instruction on the means, to achieve the horizontal and vertical system status detection function, and the use of PID algorithm for attitude adjustment. Microcontroller entire control principle is shown in Figure 2.

(3) Through the image display of TFT LCD, a model rocket launch attitude can be clearly shown. If the calculated result exceeds the reference threshold range, the alarm circuit will automatically send an alarm signal. Then, the operator can control controls the rotation of the stepping motor in short distance by the wireless keyboard, to regulate the launch platform attitude until rocket attitude in the safe emission limits.

2. DETECTION DESIGN

2.1 Mechanical structure design

The main idea of the mechanical structure design of the system are as follows: embedding the nuts in steel platform support frame; connecting couplings with the screws on the step motor to make the step motor control the vertical movement of the platform; steel support frame with a stable platform triangular structure, which is conducive to stable rocket launch; damping launch platform consisted of a double acrylic plate, between the plate and the plate by a screw nut; springs were disposed in the outer screw, sandwiched between double plate.

By and large, the mechanical structure design of the system is beneficial to the manual adjustment and plays a good role in shock absorption and control action. The protective cover outside the circuit protects the control circuit from external interference adverse conditions.

2.2 Attitude detection design

The detecting apparatus of the present system is mainly composed of MMA845X triaxial accelerometers and pressure sensors. Since the accelerometer in the horizontal direction is not sensitive to changes in value, and detecting a single direction, so they were placed in three sides of rocket base. Therefore, operators can more accurately read acceleration values in three directions, which can be drawn angle or offset, and accurately detect specific model rocket posture inclination angles. Three pressure sensors were placed on the launch platform horizontally symmetrically, which formed an equilateral triangle, for detecting pressure changes caused by the changes in the position of the center of gravity of the rocket. The A/D converter detects the vertical attitude parameters of the rocket.

The working principle of the system detecting device shown in Figure 3, is the use of calculating the weighted average of the sensors values collected by the detecting device based on Kalman filtering algorithm, and K60 obtains accurate values through...
IIC protocol. In this process, in order to avoid the influence of environmental factors, firstly detect the vertical angles and the values of horizontal pressure under the environmental standards by detecting device; normalize the data to obtain their relative values; then receive the relatively accurate value through the program amplification process; according to the laws of these numbers, fit the actual physical quantity units to give the corresponding angle values and the corresponding pressure value. That is, the attitude parameters of the rocket. In the end, transmits parameters to the display unit.

The development environment of the system is IAR Embedded Workbench, which is able to provide the micro-controller K60 with a complete set of application development module. Through the PE-micro and the microcontroller, it can easily download the target program. IAR Embedded Workbench is powerful and its interface is neat. Besides, it has characteristic serial communication, in circuit debugging, in circuit programming and other traits, and the system operation is shown as Figure 4.

2.3 Human-Computer interaction design

The human-computer interaction ('HCI' for short) module of the system is divided into three parts: parameter adjustment unit, a display unit, a voice alarm. However, in the display unit, the rocket horizontal position and vertical position are displayed on two different screens: TFT serial intelligent colorized screen, through the communication with the single chip microcomputer, digitally displays the model rocket horizontal attitude in the x, y, angle z in different directions, as well as the vertical posture pressure values on the platform in different three orientations; The other unit—the basic serial HIMI LCD screen can realize the real-time display of different vertical postures through the serial UART and PC programs.

In order to be more convenient for the operator to adjust the attitude of the rocket and overcome the error caused by the naked eye in traditional way, the system design includes the wireless transceiver module. This module combines Bluetooth Master UART Board Bluetooth module, DIP switches, and the PC program, and adopts the "fixed baud, 8 data bits, no parity" communication format for Bluetooth serial port. As a result, the module can achieve the communication between Bluetooth Master UART Board Bluetooth module and the DIP switches, so that it can control the rotation of the stepping motor, the short distance wireless monitoring of rocket attitude, to further enhance human-computer interaction.

On top of that, in order to overcome the uncertain impact of human judgment on rocket launch, we set the scheduling module in the microcontroller. This module enables the operator to set the reference angle range for model rocket platform and the center of gravity position. Once the test results exceed the threshold range, the alarm circuit will issue an alarm signal immediately, so that the alarm light flashes to alert the operator to adjust the rocket attitude.

3. CONCLUSIONS

The system joins the angle sensors and force sensors, instead of the traditional way to manually adjust the emission profile. Besides, it can overcome the shortcomings that the center of gravity is not rocket projection center, and achieve an intelligent launch...
platform. It can not only detect the precise parameters for specific attitude rocket at the same time, but also avoid bringing the damage to rocket launching in the traditional manual adjustment. Thereby it saves the cost of launching. In addition, the system creatively added HCI module, image display, and alarm function, which is more convenient for the operator to adjust the rocket launch, and makes the system more strong scientific and practical.

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