A4 PAPER HYBRID DIGITAL VOLTAGE RECORDER

CONTROL SYSTEMS AND INSTRUMENTATION ENGINEERING PROGRAM

Teeratep Homkhajron, Patarachai Srimuang, Chanin Tangkitwanitchakun Advisor : Wutthichai Polwisate

Abstract

This project focuses on the study and development of A4 paper digital recorder.The recording of signals using a "Hybrid Recorder" combines both digital and analog recording methods to enhance stability, data clarity, and resilience to various environmental conditions. Paper recording facilitates easy access to the data, while the integration of both systems adds versatility in operation and reduces costs associated with various industries. This applies to recording sound, images, or radio data, not only maximizing efficiency but also allowing for customization and data management according to user needs. The Hybrid Recorder technology advances service provision and diverse applications, serving educational purposes for understanding its operation principles, and designing and constructing such recorders. It utilizes motors for paper drive and paper movement to record analog signals and employs a digital display screen for digital data presentation, with a touch screen interface for convenient settings adjustment

System Overview

A4 PAPER HYBRID DIGITAL VOLTAGE RECORDER will receive input values from the Function generator and convert the values by ADC convertor which can be displayed on the raspberry pi screen and can command various functions by touching on the screen.

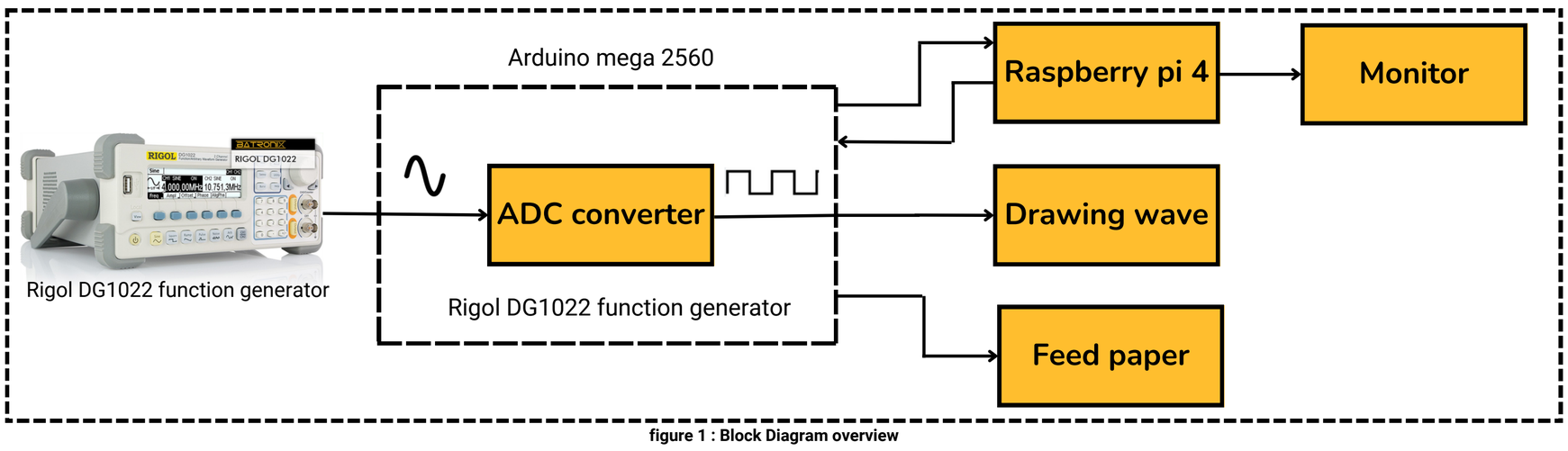

figure 1 : Block Diagram overview

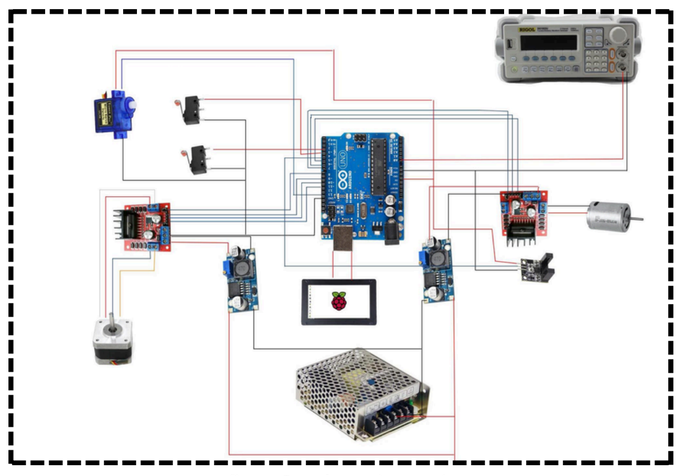

figure 2 : schematic overview

Method

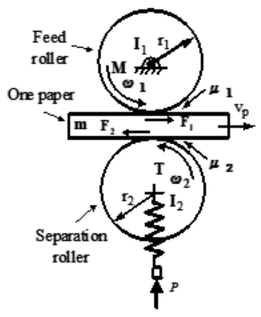

figure 3 : friction feed paper

- **Paper Feed Mechanism: Mechanical roller type with reversing roller. By considering the modified Coulomb friction force. Depending on the reverse torque, the feed roller will rotate at a constant speed and the reverse torque will be reversed.**

By conditions

(1)The paper feed velocity decreases as the reverse torque increases.
(2) The friction forces acting on the upper and the lower of the paper are equal to the reverse torque divided by the roller radius.
(3) The paper feed velocity is determined from the slip velocity at each contact surface, which is obtained from the modified Coulomb friction equation.

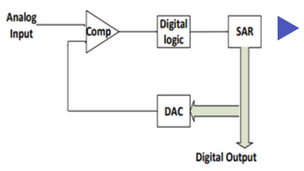

figure 4 : Successive Approximation ADC

- **A Successive Approximation ADC (Analog-to-Digital Converter) is a type of ADC commonly used in digital systems to convert analog signals into digital form. It works by iteratively approximating the analog input voltage with a series of binary-weighted comparisons.**

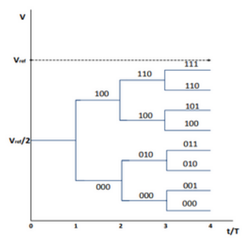

figure 5 : Waveform of SAR ADC

steps involved in the operation of a Successive Approximation ADC:

1. **Initialize: Set up parameters like resolution and reference voltage.**
2. **Sample: Take a sample of the analog input.**
3. **Compare: Compare the sampled value with digital representations.**
4. **Approximate: Iteratively adjust digital output based on comparisons.**
5. **Complete: When all bits are determined, conversion is done.**
6. **Output: Make the digital output available.**

figure 6: Processing program

- **Processing is a free graphics library and integrated development environment (IDE) built for the electronic arts, new media art, and visual design communities with the purpose of teaching non-programmers the fundamentals of computer programming in a visual context. use for create an UI**

Conclusion

A4 PAPER HYBRID DIGITAL VOLTAGE RECORDER now can do up to The screen displays 3 types of signals and push buttons on the touch screen and indicates the starting position of the Stepper motor as well as receiving INPUT values from the Function Generator to write a pen to determine the speed of the speed chart. But there is still a problem with writing the graph on paper and The speed of paper feeding is still not as stable as it should be. The graphs that show on displayed screen inconsistent with the graphs that draw on a paper.

Result

- **Test the encoder to measure the speed of paper feed**

Test by using the encoder to count the number of revolutions and then converting it into speed in cm/s. Then compare it with the physical measurement of speed by measuring distance over time to find velocity.

The formula

$$\text{Speed} = \left(\frac{\text{encoderCount}}{20.0}\right) \times \text{circumference} \times \frac{1}{1000.0}$$

figure 7 : Formula for calculating encoder

Test by moving the paper and timing it three times in total to find the average speed for each interval and distance, then use these measurements to calculate the velocity

distance	PWM	TIME (S)	V(AVG)
16.1			
	55	28.66	0.561759
	56	19.41	0.829469
	57	14.61	1.101985
	58	10.69	1.50608
	59	8.86	1.817156

figure 8 : Experimental results of measuring the motor speed by measuring distance over time

- **Testing receiving input values from Function Generator to write a pen.**

Test method :

- **Test the input value by recording the analog voltage value. For conversion into 10-bit digital values, there are 500 numbers.**
- **Save to Excel and draw a graph to compare with the graph that was pressed from the Function Generator.**

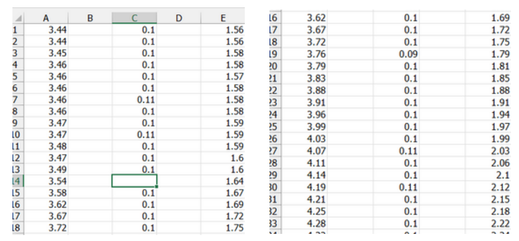

figure 9 : Data 500 set

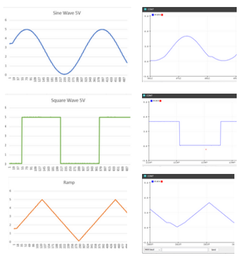

figure 9 : Waveforms

- **3 types of graphs that show on displayed screen from Processing IDE**

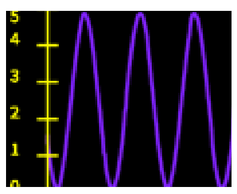

figure 10 : sine wave

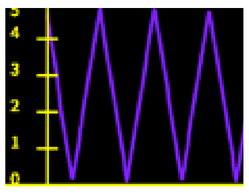

figure 10 : Ramp wave

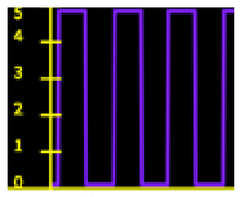

figure 10 : square wave

References

[1] Nisa Nacar Cikan Cukurova University , Department of Electrical and Electronics EngineeringAdana,Turkeyncikan@cu.edu.tr

[2] Murat Aksoy Cukurova University , Department of Electrical and Electronics Engineering Adana,Turkey aksoy@cu.edu.tr

[3] Shigeo YANABE, Yuhei HOSOKAWA and Takayuki MAEDA, FEM SIMULATION OF PAPER FEED MECHANISM WITH REVERSE ROLLER, 2003 Department of Mechanical Engineering, Nagaoka University of Technology Kami Tomioka, Nagaoka-shi, Niigata 940-2188, JAPAN