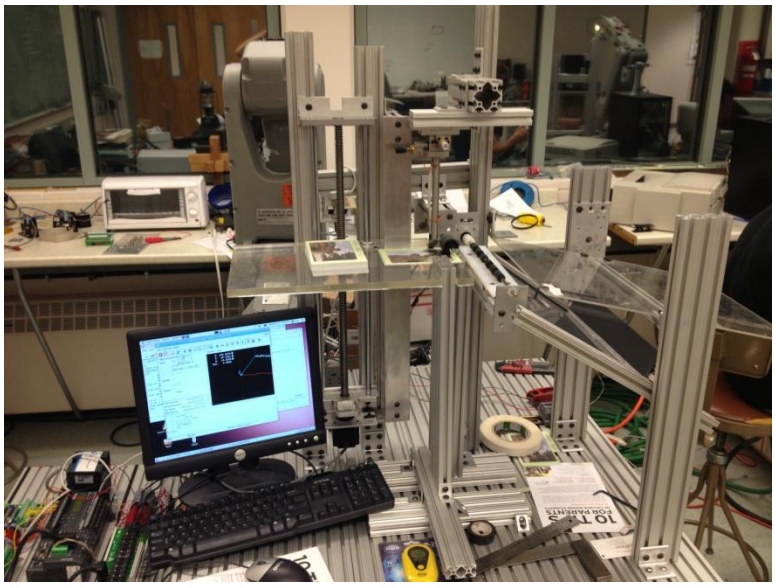
WALLA WALLA UNIVERSITY

Intellipaper Testing Machine Manual

Final Project for ENGR 480



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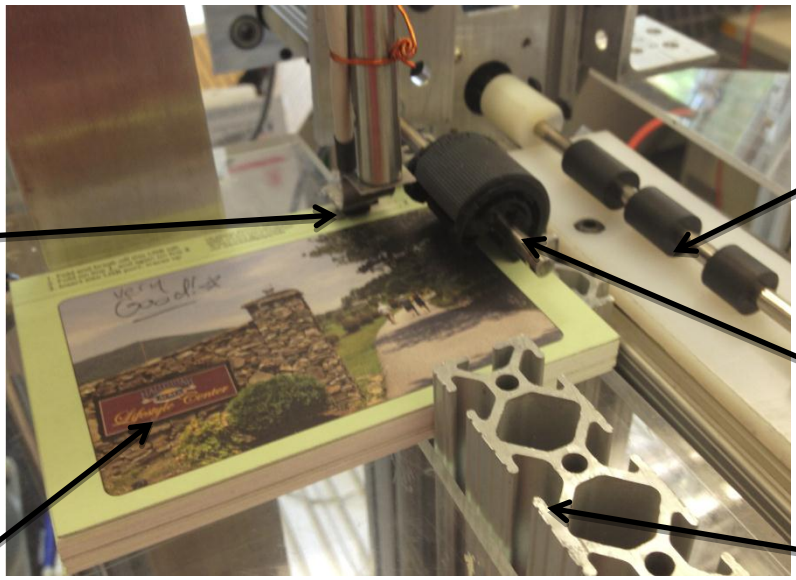
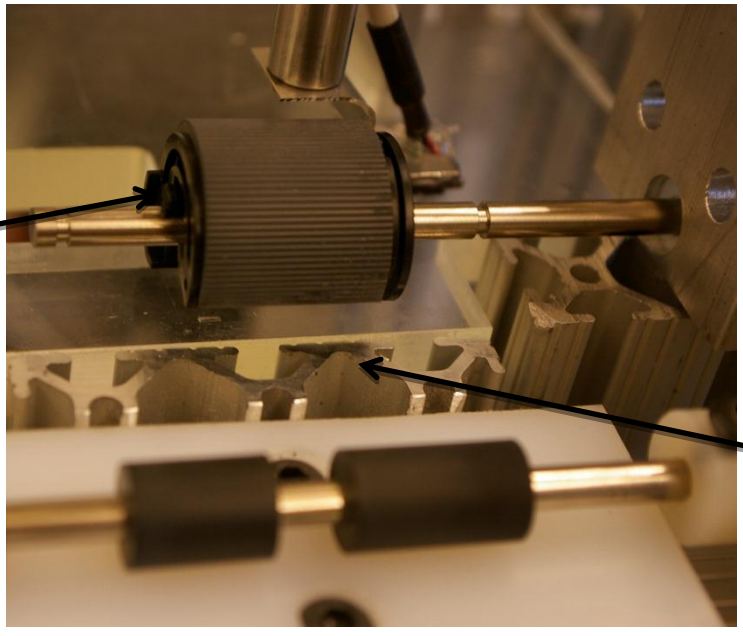
Parts and Operations

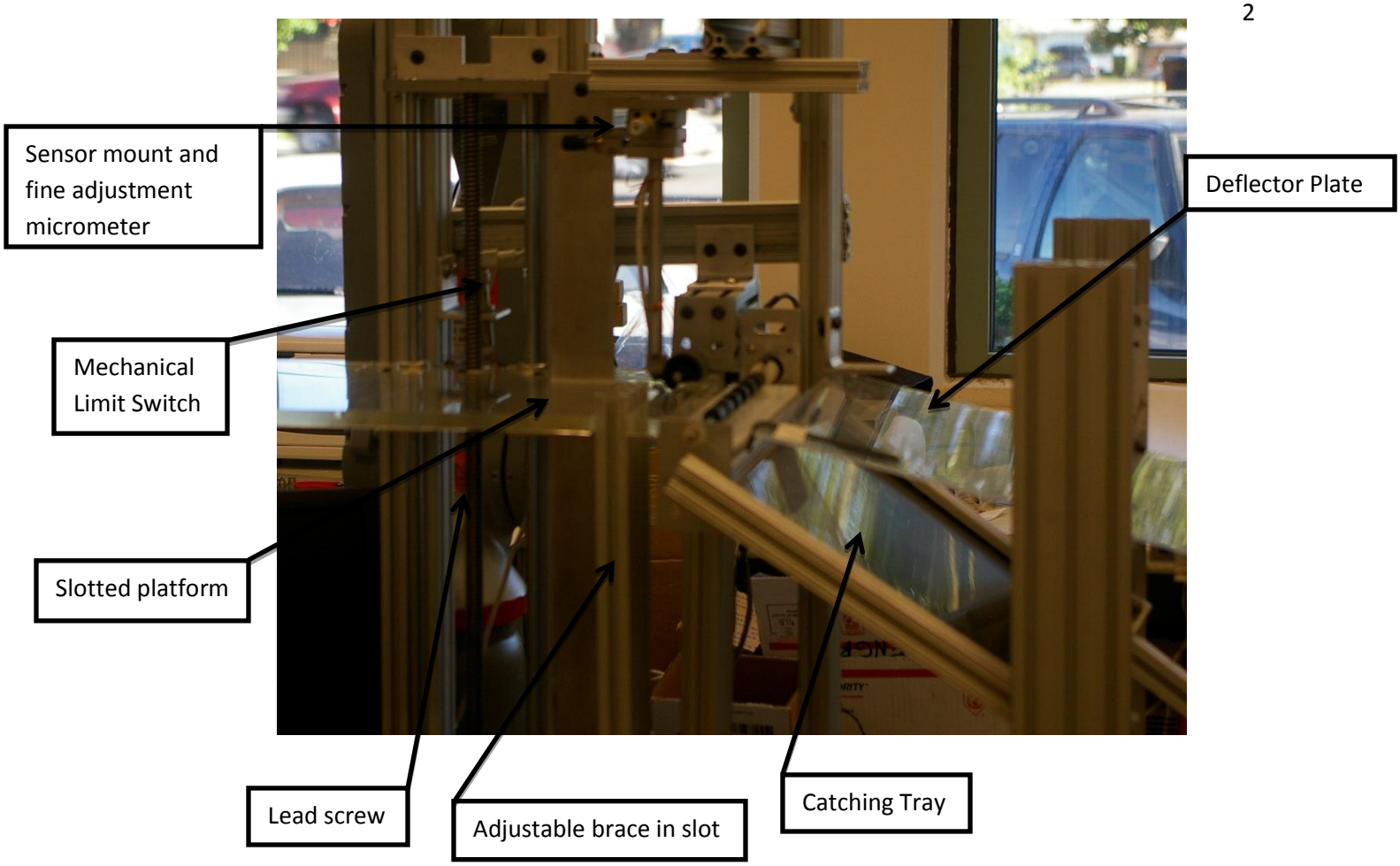
Overview

This machine tests and sorts Intellipaper USB cards. These cards are made of layered paper and a lightweight flash drive with USB contacts printed onto the surface of the cardstock in one corner. The cards are loaded in a stack on the platform, and then the platform lifts the stack up to a fixed sensor and roller assembly. After testing, Roller 1 pushes the top card of the stack towards Roller 2 so that Roller 2 can pull it off the stack to be sorted. Untested cards are held in place against a fixed stop. If the test indicated that the card is bad, the solenoid is activated to tip the deflector plate to intercept the card. Otherwise, the card continues down to the catching tray. Rejected cards pass over the deflector plate into a bin.

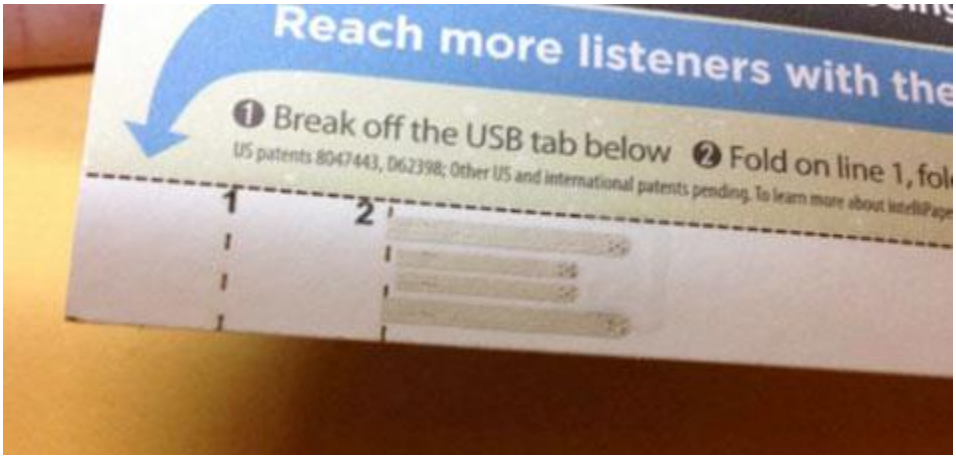


The unstacking roller is not round. It is shown in neutral position so it won't put pressure on the paper while the ejector roller pulls the paper away.





This system is advantageous because it has the potential to be very fast because movement is minimized. The components are relatively cheap because it requires no robotics, pneumatics, or PLC control. The machine also has the potential to process a large stack of paper, limited only by the length of the lead screw. Switching between sizes of paper requires the operator to adjust only one guide rail and the backstop of the catching tray.



Parts List

- Motors: Two Automation Direct SureStep STP-MTR-17048 for the rollers and one STP-MTR-23055 for the lead screw.
- Solenoid: One Electro Mechanisms 24V solenoid to operate the deflection plate.
- Sensor adjustment: One two axis micrometer optics mount.
- Rollers: Rollers 1 and 2 were scavenged from an old printer.
- Lead screw and platform: The lead screw is a ½ in diameter, 2 ½ ft tall screw with two guide rods. The platform is slotted to accommodate braces which keep the stack of paper aligned with the sensor and rollers. The g-code to mill the slots and holes is given in this document.
- Frame: Extruded aluminum square members mounted with brackets and t-nut fasteners.
- Catching Tray: Plastic base and adjustable backstop catch the good cards. Bad cards are deflected over the catching tray by the plastic deflection plate.
- Computer: Dell desktop running Linux CNC and interface.
- Limit switch: Inductive proximity switch

Loading Machine

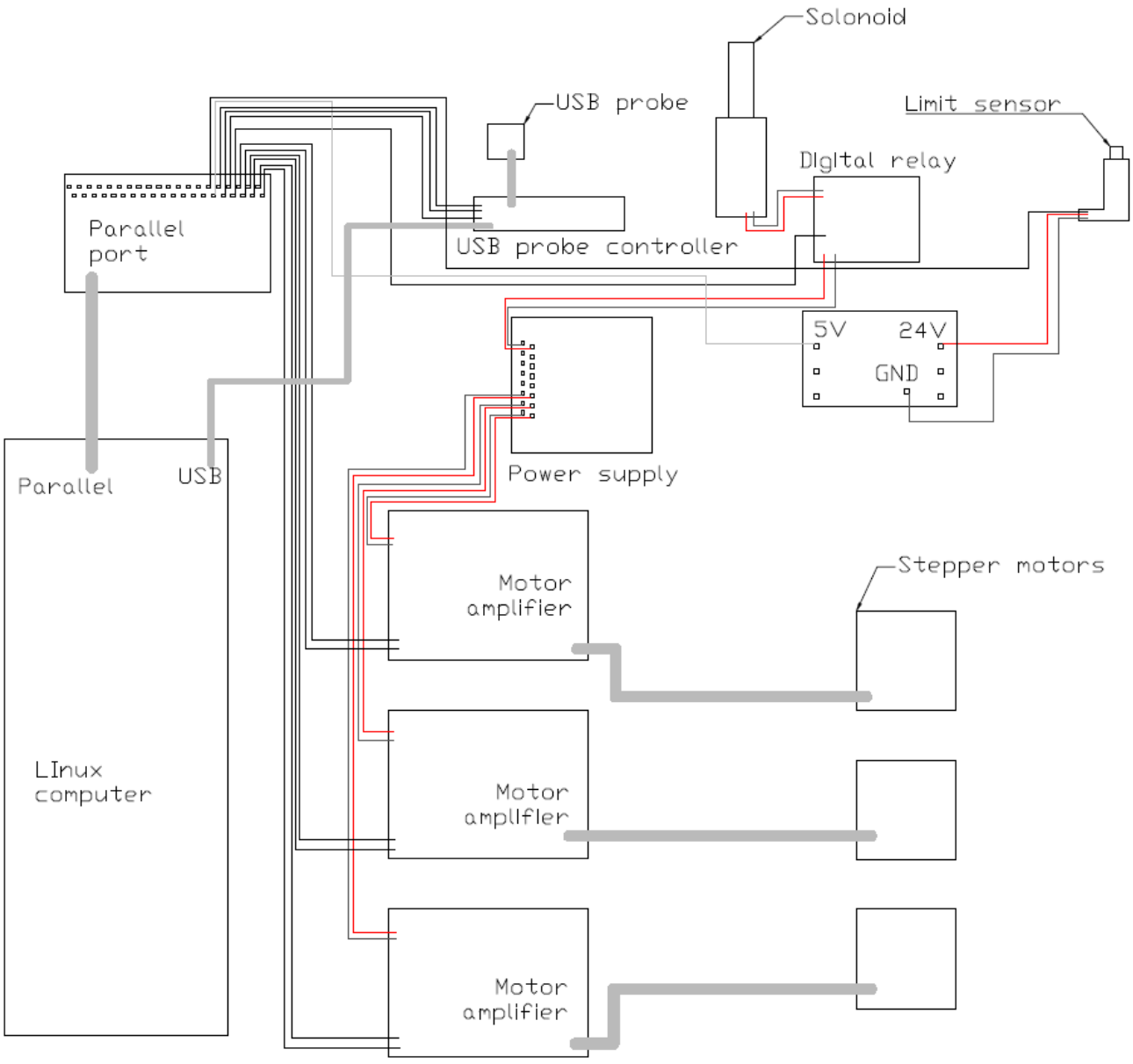
1. Remove old cards from Table and Trays or obstructions from card platform.
2. Turn on system.
    a. Linux Computer
    b. Power Source
    c. Plug in Card reader USB
3. Launch Linux CNC “Trial” program from Desktop.
    a. Unlock the CNC controls
    b. Toggle machine power.
    c. Home the x, y, and z axis.
    d. Load the “Lifter Code” file.
4. Press “Page Down” to lower the card platform to allow for stacking the desired amount of cards. “Page Up” if you have gone too low.
5. Adjust the vertical brace by sliding it away from the sensor area and lower platform to so that they are firmly held but not pinched toward sensor.
6. Place untested cards in a stack snugly against the braces with the USB contacts underneath the sensor.
7. Adjust sensor position and orientation as needed to align the sensor contacts with the USB contacts.
8. Adjust backstop position on the catch tray to match the size of cards.
9. The ejection roller needs to have the “no contact” portion of the roller towards the cards to start so that it is not contacting the first card.
10. Click the “Begin running current file” Button to **Start** the Process.

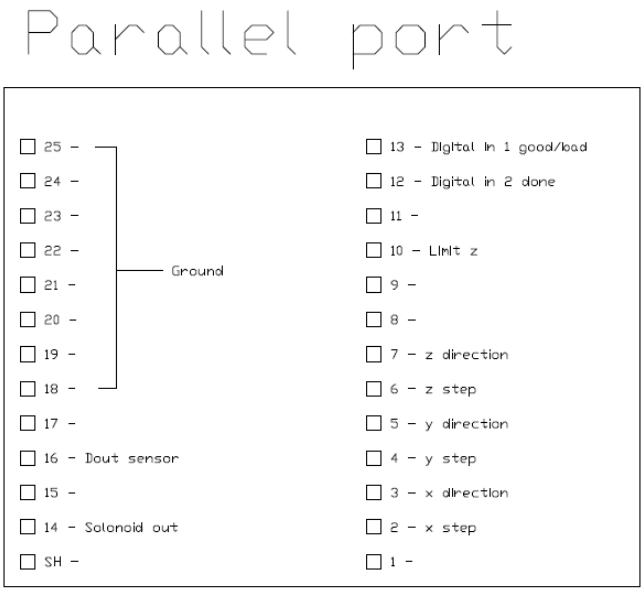
Stepper Motor Configurations

Motor 1: Unstacking roller corresponds to the Y axis. One revolution is 0.25 units.
Motor 2: Ejector roller corresponds to the X axis. Ejects with 4.0 units.
Motor 3: Lead screw corresponds to the Z axis. Increment per card is 0.19 units.

X Axis	**Value**	**Units**
Motor steps per revolution	200	
Driver Micro Stepping	2	
Pulley Teeth	1	
Lead Screw pitch	20	rev/in
Max Velocity	1.5	in/s
Max Acc	30	in/s^2
Home location	0	
Table Travel	0 to 99999	
Y Axis	**Value**	**Units**
Motor steps per revolution	200	
Driver Micro Stepping	2	
Pulley Teeth	1	
Lead Screw pitch	100	rev/in
Max Velocity	1.25	in/s
Max Acc	30	in/s^2
Home location	0	
Table Travel	0 to 99999	
Z Axis	**Value**	**Units**
Motor steps per revolution	200	
Driver Micro Stepping	2	
Pulley Teeth	1	
Lead Screw pitch	20	rev/in
Max Velocity	1.5	in/s
Max Acc	30	in/s^2
Home location	0	
Table Travel	-300 to 1000	

Wiring Diagram





Clearing Jams

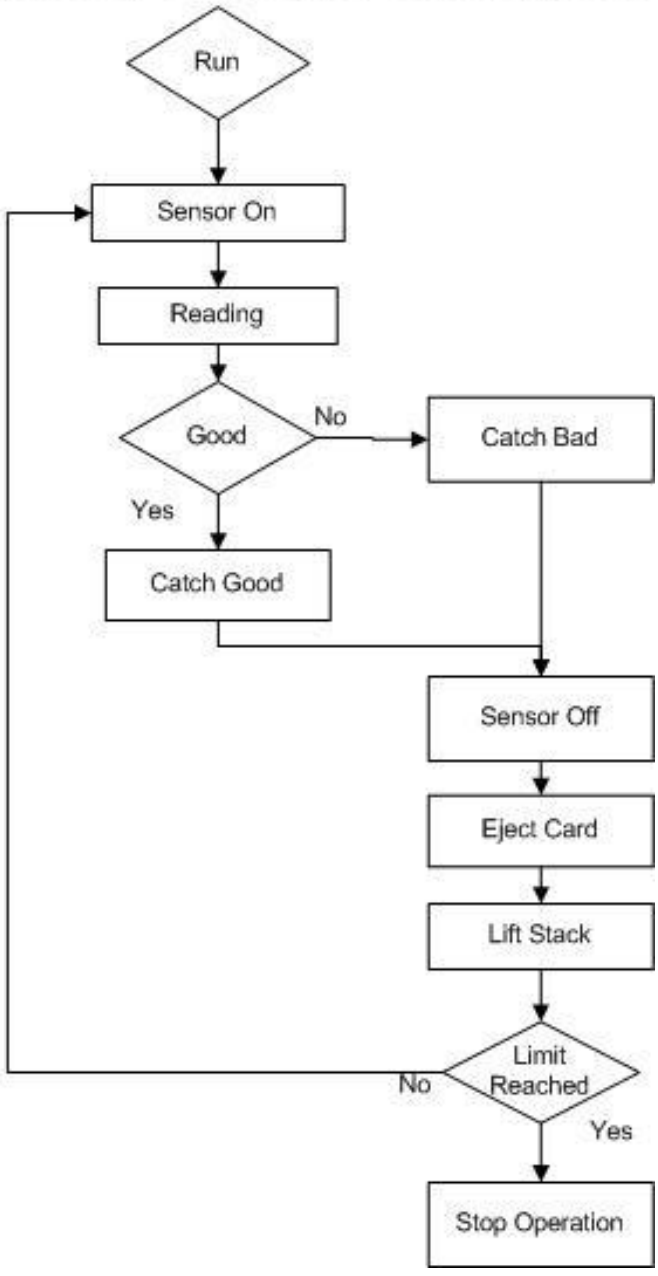
If the rollers pull more than one card out of the stack at a time, pause the system, and then manually run the unstacking roller (X-axis Roller 2) until the cards are clear. The jammed cards can then be put back on the incoming stack.

If a card does not get fully ejected past Roller 1 before the next card is read, it may cause backup. Manually run the both Roller 1 and Roller 2 until the card is free and replace the card on the stack.

A jam can be created if a card is not ejected and the Z axis lifts up another card. Without a spring on the sensor the extra card thickness can pinch the top card not allowing it to be ejected. Then the z axis will rise again and continue the jam. To fix this the system must be stopped and the excess cards must be removed so the stack is back to operational height.

If the Stack has too many bad cards in it, the rejection tray may need to be cleared to keep the proper weight balance for the rejection solenoid to work properly.

Flow Chart of G Code Operation



Performance

On June 12, 2013, we tested our system by testing and sorting a set of 200 cards where bad cards were pre-marked and the type of error indicated. Unmarked cards were tested to be good by Intellipaper. Our system could test and process 1400 cards per hour if it was running without any errors. If we increased the speed of the rollers and cut out any unnecessary pauses we might be able to reach 1800 cards per hour.

Currently, consistency issues and sensor reliability limit us to speeds of about 2.60-2.65s/card. Sensor accuracy is questionable because we are getting a significant number of false positives. Alignment is not an issue because our sensor appears to line up very consistently. It seems that pressure between the sensor and card is the largest factor in causing these issues. We had very few bad cards make it into the good stack, but a significant number of cards. Because the friction between brand new cards is higher than our worn test cards, we had some issues with cards not being pulled all the way out of Roller 2 before the next card is ejected. This problem was largely mitigated by adjusting the pressure of the rollers and sensor on the stack.

Future Improvements

1. A suspension system should be added to the tip of the sensor assembly so that the sensor causes less friction when ejecting cards.
2. Modify the card rejection plate so that cards will slide all the way over it without becoming stuck, adjust the weight distribution on the plate, and add a second solenoid to make it more reliable or switch out the solenoid for another stepper motor.
3. Configure the settings in Linux CNC so that the feed rates of each axis can be controlled independently so that
4. The bolts that hold the unstacking wheel and sensor assembly should be replaced with hand adjustable fasteners so that their height can be varied without tools.
5. Replace the frame with less bulky supports and move everything closer together.
6. Use custom ordered rollers instead of scavenged printer rollers.
7. Add a free spinning wheel that provides downward force on the side of the card opposite of the sensor to reduce the unevenness of the stack and prevent jamming when there are just a few cards left.
8. More Funds for parts.

G-Code for operation and manufacture of components.

G-code for system operation

```
%
(AXIS,stop)
O100 WHILE[1]
G91
       M64 P0
       M66 P2 L3 Q100
O102 IF [#5399 EQ 0]
       M8
O102 ELSE
       M9
O102 ENDIF
       M65 P0
G1 Y0.25 X4.0 F2000
G1 Z0.19 F100
0100 ENDWHILE
M30
%
```

G-Code for machining platform slots and mounting brackets.

```
(G54 ZERO- RIGHT BACK TOP)

G54
G00 G40 G90 G17 G20

(SPOT DRILL HOLES - FOR 3MM HAND DRILLING)
T7 M6
G43 H7
S2000 M3
G0 X-4.5 Y-0.5 Z0.1
G81 Z-0.1 R0.1 F10.;         (DRILL CYCLE)
X-4.5 Y-0.5
X-4.5 Y-1.25
X-4.5 Y-2.00
X-11.5 Y-0.5
X-11.5 Y-1.25
X-11.5 Y-2.00
X-7.125 Y-0.5
X-8.875 Y-0.5
X-5.51  Y-2.25
X-8.0  Y-2.25
X-10.49 Y-2.25
G80 G00 Z0.2;                (CANCEL CANNED CYCLE)
M09
M05
(BORE LARGE HOLES WITH 0.25IN EM)
T4 M6
G43 H4
S2000 M3

(FIRST SHAFT HOLE)
G65 P99001 X-6.0 Y-0.9375 Z-0.520 R0.1 D1.05 K0.10 F6.0
(MOTOR BOSS HOLE)
G65 P99001 X-8.0 Y-0.9375 Z-0.520 R0.1 D1.15 K0.10 F6.0
(SECOND SHAFT HOLE)
G65 P99001 X-10.0 Y-0.9375 Z-0.520 R0.1 D1.05 K0.10 F6.0
M09
G00 Z6.0
M5
M30
%
```