Automated Ream Opener
(Physical Design)

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Activity Report

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1 PHYSICAL DESIGN

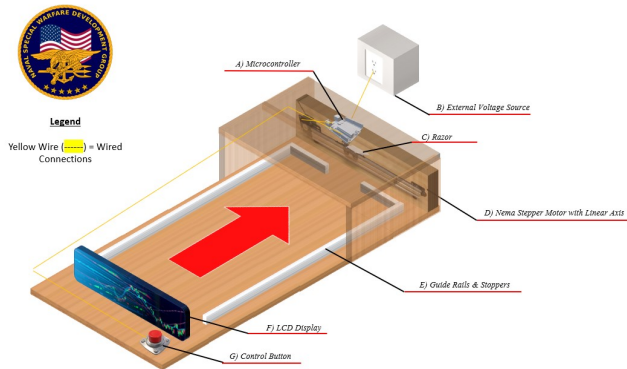## 1.1 Engineering Diagram

Figure 1. Annotated diagram of the proposed solution.

Physically speaking the device is quite simple in nature and requires minimal overhead to implement. The design is centered around a linear axis rail operated by a NEMA stepper motor. This contraption is capable of controlled uniform movement and as such when a razor blade is attached to the sliding linear cart it will ideally make clean lacerations to the paper ream cover. A user interacts with the system via a button press that controls the operation

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of the linear rail. Along the base of the apparatus there are guiding protuberances that orient the ream in the most optimal setting. These "stoppers" ensure that only the cover of the ream will be slit, thereby leaving the contents unperturbed.

1.2 Parts List & Budget

The noted parts are preliminary and likely subject to change. Likewise, cost is expected to increase as additional components may be necessary. Observe the parts list and budget shown on Table 1. These detail the components germane to our prototype.

1.3 Software Dependencies

The following represents the software dependencies of the system.

1) **Software: Arduino IDE**
   The open-source Arduino Software (IDE) is used to write the code and upload it to the board. The code controls the rotation speed, and time the stepper motor rotates for. The code also contains the logic through which the stepper motor rotates in one direction when the push button is pressed and then the opposite direction when the push button is pressed again.

1.4 Equipment Dependencies

The following represents the equipment needed for testing the system.

1) **Equipment: Paper Ream**

Item	Part #	Supplier	Cost	Description
Belt Driven NEMA 17	1070-Bundle	OpenBuilds	$94	Drive system
Wires	20 AWG	Amazon	$15	Connections
Motor Driver	A4988	Amazon	$10	Integrates NEMA 17 and microcontroller
Microcontoller	Ard. MEGA R3	Amazon	$21	Executes Software Logic / Controller
Razor Blades	SK2H	Amazon	$5	Cut ream
Paper Tray	CC431-60119ADF	Amazon	$20	Load paper
Power Supply	12V 2A	Amazon	$9	Power NEMA
TOTAL			**$175**	

Table 1
System Parts List & Budget

The purpose of the system is to remove the outer package of the paper ream.

2) **Equipment: Belt Driven Linear Actuator**
This is an essential element of the system. A belt driven linear actuator is controlled by a stepper motor and contains a shuttle to which razor blades are attached. It enables the razor blades to move across the sides of the paper ream.

3) **Equipment: Razor Blades**
Utility knife blades are attached to the shuttle on the belt driven linear actuator. These blades enable the system to cut open the outer package of the paper ream.

4) **Equipment: NEMA 17 Stepper Motor**
The stepper motor controls the belt driven linear actuator and is a key component in the functioning of the system. It is a necessary aspect in component testing.

1.5   System Integration & Standards

Engineering standards establish technical criteria, methods, processes and practices. In the current system, there is one communication standard (protocol) being utilized.

1) **Standard: UART Protocol**
UART ports communicate between only two devices (transmit and receive). Both devices must agree on data and communication speed ahead of time and requires complex hardware. There is no control over when the data is sent and no guarantee that both sides are running at the same rate. To achieve reduced data rates, at least one start and stop bit is a part of each frame of data.