

Automatic Sterilizing Currency Counter

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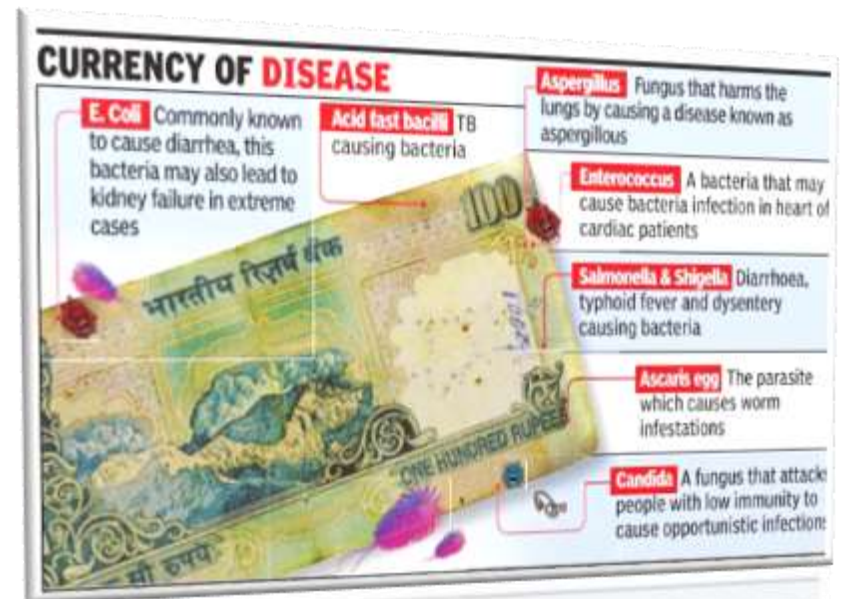
Introduction

- ❖ Money is one of the dirtiest things you can touch.
- ❖ Paper money can reportedly carry more germs than a household toilet.
- ❖ Viruses and bacteria can live on most surfaces for about 48 hours, but paper money can reportedly transport a live flu virus for up to 17 days
- ❖ The rapid spread of the corona virus infectivity has raised concerns over surface-to-humans transmissions, including through currency notes.



Motivation of Project

- ❑ 21.1 trillion currency notes are in circulation among the people in 2019 financial year which is 17% higher than the previous years (RBI)
- ❑ This increases the panic level of spread of micro-organisms through the currency notes circulation which leads to the spread of diseases like COVID-19.
- ❑ The currency note may act as the carrier of these dreadful diseases which needs engineering solution to avoid this problem



Literature Survey

S. No	Journal Details	Title	Authors	Approach	Conclusions and Remarks
1	Pub. No.: US 2007/004 5081 A1	CURRENCY SORTING /CLEANING CASE AND CURRENCY SORTING CASE	Toshiaki Sugawara, Yamagata (JP)	The system comprises a coin receipt casing, a paper money receipt casing, a coin-oriented detergent reservoir and a paper money-oriented detergent reservoir Installed within the coin receipt casing such that the coins are charged through an opening/closing type coin charge opening the cleaning case is held substantially to sort the charged coins.	The introduced system particularly solved difficulties by sorted reception of coins and paper moneys while counting with simultaneous disinfection of circulated currencies without the leakage of a detergent to the exterior. This encourages a new manner for environmental hygiene by currencies.

Literature Survey

S.No	Journal Details	Title	Authors	Approach	Conclusions and Remarks
2	Pub. No.: US 2011/0253 563 A1	CURRENCY STERILIZATION APPARATUS	Edward Goldman, Framingham, MA (US)	A currency storage, purification and distribution system consists of a cash box system, a money receiving disbursing box utilizes the ventilated cash drawer mechanism with an ultraviolet light administration system, disinfectant system in communication with the cash box.	The apparatus provides a multi-configuring function for receipt, retaining, sterilization, disinfecting and disbursing of bank notes specifically to a currency handling device The retrofitted cash drawer comprises a perforated design to allow for surface exposure and currency desiccation quality.

Literature Survey

S.No	Journal Details	Title	Authors	Approach	Conclusions and Remarks
3	Pub. No.: US 2015/0359 914 A1	BILL STERILIZER EQUIPPED WITH COUNTING MACHINE	Myung Soo BAEK, Gangwon-do (KR)	The embodiment of the invention includes a counting machine for counting the bills, a body for receiving the counting machine, a tray for guiding the counting machine, an ion generator , a door for selectively blocking and a door lock for locking the door in the inside of the body.	The machine equipped with the counting machine supplies cluster negative ions to the sterilizer body are evenly transferred to the surfaces of the bills, thereby removing pollution sources of the bills.

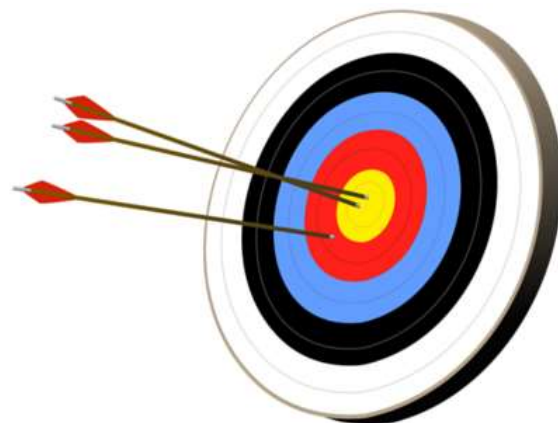
Summary of Literature Review

- The present invention incorporates an combined method for sterilizing bills with cash counting which is not available in the market.
- The introduced system fetch and carry the bills separately for higher sterilization and counting outweigh the bundle of currency bills.
- The upcoming model make use of UV-C to kill germs in the currencies in contrary with some chemicals, detergents and disinfectants..
- .The developed system is portable to use in banks ,hospitals, supermarket surpass the sterilizing lamp in ATM hopper.

Objective

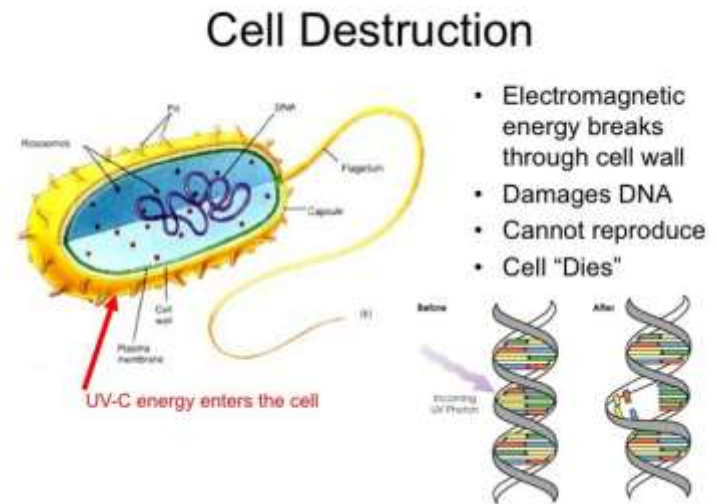
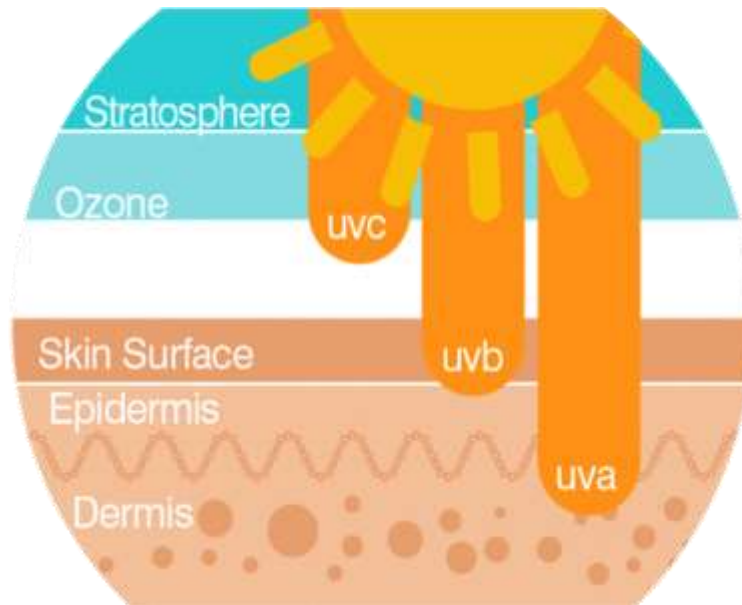
The objectives of the project are as follows:

1. To design and fabricate a device “Automatic Sterilizing Currency Counter” incorporating an optimum method to sterilize the currency bills during cash counting.
2. To ensure efficient counting and higher sterilization rate with the incremental UV dose log reduction to inactivate the spread of microbes.

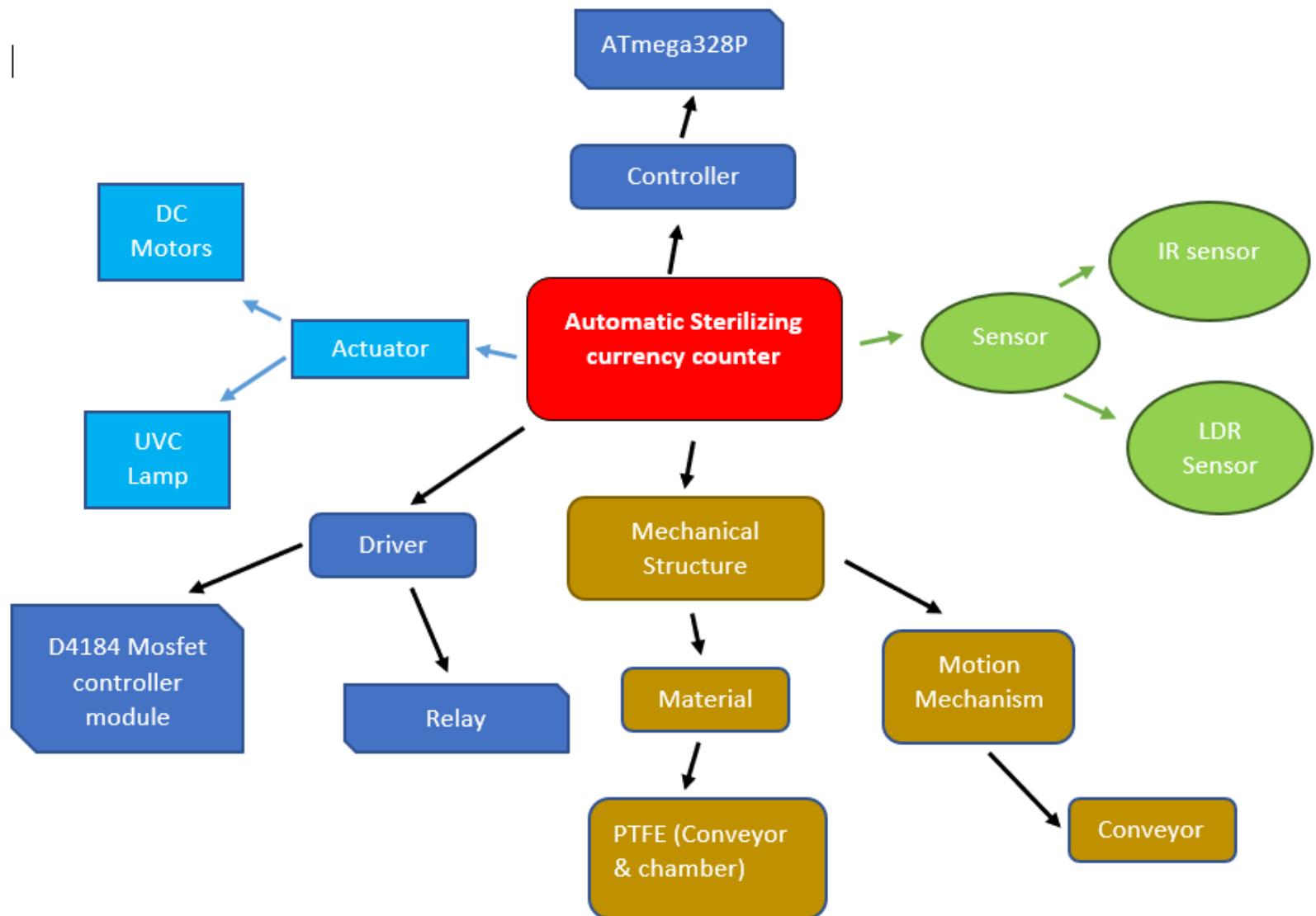


Working Principle

- Ultraviolet germicidal irradiation (UVGI) is a disinfection method that uses short-wavelength ultraviolet (UV-C) light to kill or inactivate microorganisms by **destroying nucleic acids and disrupting their DNA**, leaving them unable to perform vital cellular functions.



Conceptional Design



Design Calculation

UV DOSE CALCULATION

s.no	Micro-organism	UV dose for 1 log reduction $\mu\text{Ws}/\text{cm}^2$	UV dose for 2 log reduction $\mu\text{Ws}/\text{cm}^2$
1	E. coli	2,600	6,600
2	Proteus mirabilis	3000	6600
3	Vibrio sp	3,375	6,500
4	S.aureus	2,600	6,600
5	Salmonella sp		4100
6	Pseudomonas sp	3,500	6,600
7	COVID-19		5000

1 log reduction kill **90%** of the germs

2 log reduction kill **99%** of the germs

UV dose = intensity * exposure time

7000=145* exposure time

Exposure time = 48.276 seconds

From the table, the value of UV dose calculated = 7000 $\mu\text{Ws}/\text{cm}^2$ (maximal value)

We prefer 36Watts 145 $\mu\text{W}/\text{cm}^2$ intensity lamp and 253.7nm wavelength

Design Calculation

MOTOR SPEED CALCULATION:

Conveyor speed = currency speed= length of conveyor / Exposure time

Conveyor speed = 1meter/48seconds

$$v = 20.833 \text{ mm/s}$$

$$v = r\omega$$

$$1 \text{ rpm} = 2\pi/60 \text{ rad/s.}$$

$$V = (d/2) * (2*\pi*N)/60$$

d=50mm (Conveyor Pulley diameter)

$$20.833 = (50/2) * (2*\pi*N)/60$$

$$N = 7.96 \text{ rpm}$$

$$N \approx 8 \text{ rpm}$$

$$N = 16 \text{ (2:1 Pulley)}$$

Design Calculation

CONVEYOR SPECIFICATION

Length of the conveyor = 500+500mm

Width of each currency bills = 66mm

Capacity = Length of the conveyor/(width of currencies +clearance b/w currencies=5mm)

Capacity of the conveyor = 14 notes

For the first 48 seconds = 1 note will come

For the 2nd 48 seconds = 1+14 notes will come

For the 3rd 48 seconds = 1+(2*14) notes will come

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For the nth 48 seconds = $1+((n-1)*14)$ notes will come

For an hour, 1050 notes will get sterilized

Design Calculation

CONVEYOR BELT LENGTH CALCULATION:

The Conveyor unit comprises four conveyors:

Unit length of each conveyor $= 2(L + ((\pi \cdot D)/2)) = 2L + \pi \cdot D$

If $D=50\text{mm}$ Length $\sim 2 \cdot 500 + 3.14 \cdot 50 \sim 1157\text{mm}$

ESTIMATED CALCULATION OF PWM

Analog write value (0-255) produces distinctive PWM

Take max motor speed = 30 rpm

If analog write value = 0 means 0% duty cycle of motor speed 0rpm

If analog write value = 255 means 100% duty cycle of motor speed 30rpm

For 16 rpm, analog write value is 136

Component Specification

UVC Lamp Specification

Type	: UVC
Wavelength	: 253.7 nm
Light Intensity	: 145 μ W/cm ²
Voltage Rating	: 240V AC
Power Rating	: 36 Watts

Microcontroller Specification

Manufacturer	: ATMEL
Model no	: ATMEGA328P
Memory	: 32k bytes (flash)
I/O ports	: 28
RAM	: 2K bytes
Timers	: Two 8bit and One 16 bit

Component Specification

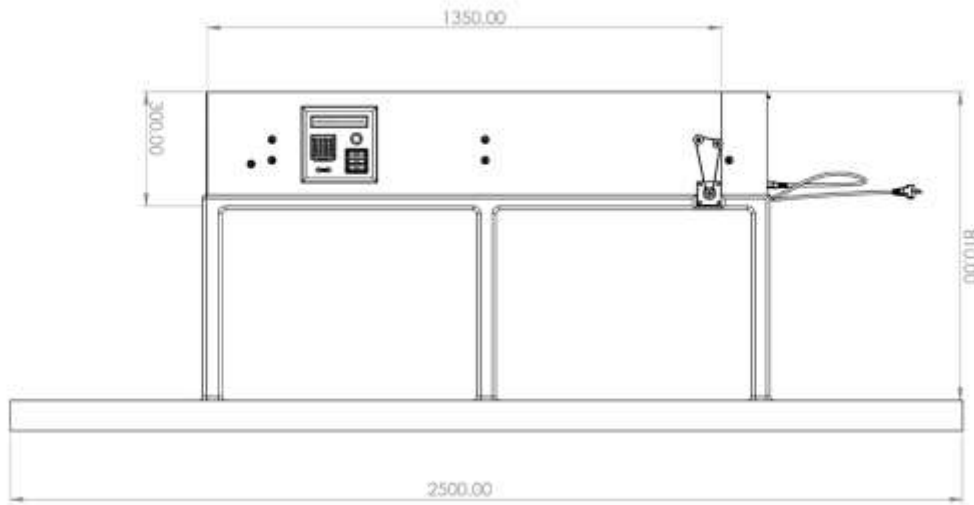
Motor Driver Module D4184

Model no	: D4184 Mosfet
Rds(on)	: 8.5mΩ
Logic Signal (Input)	: 3.3 and 5V
MAX Voltage Rating	: 6 -36V
MAX Current Rating	: 10A
Special Feature	: Opto isolation, PWM Compatible

Electronic Relay Specification

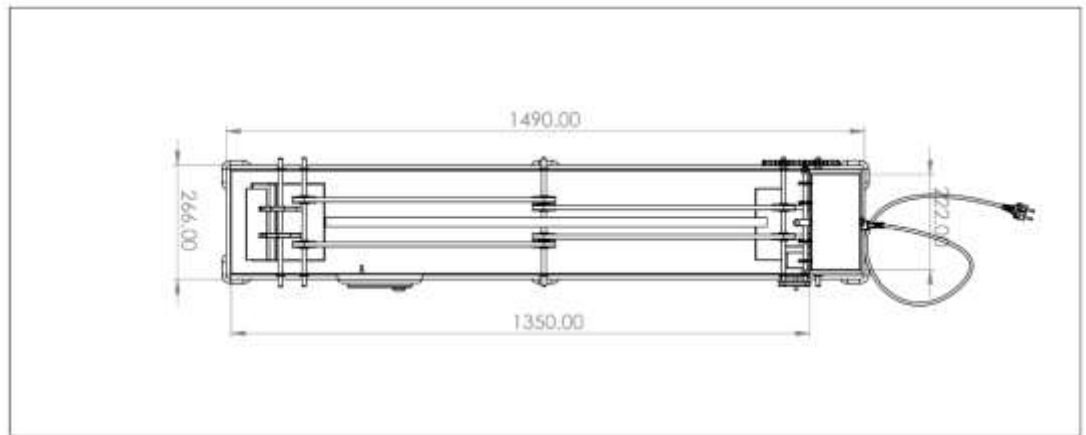
Type	: Single point relay
Coil voltage	: 5 V/DC
Operating voltage	: 250 VAC/10A---28VDC/10A

2D Sketch

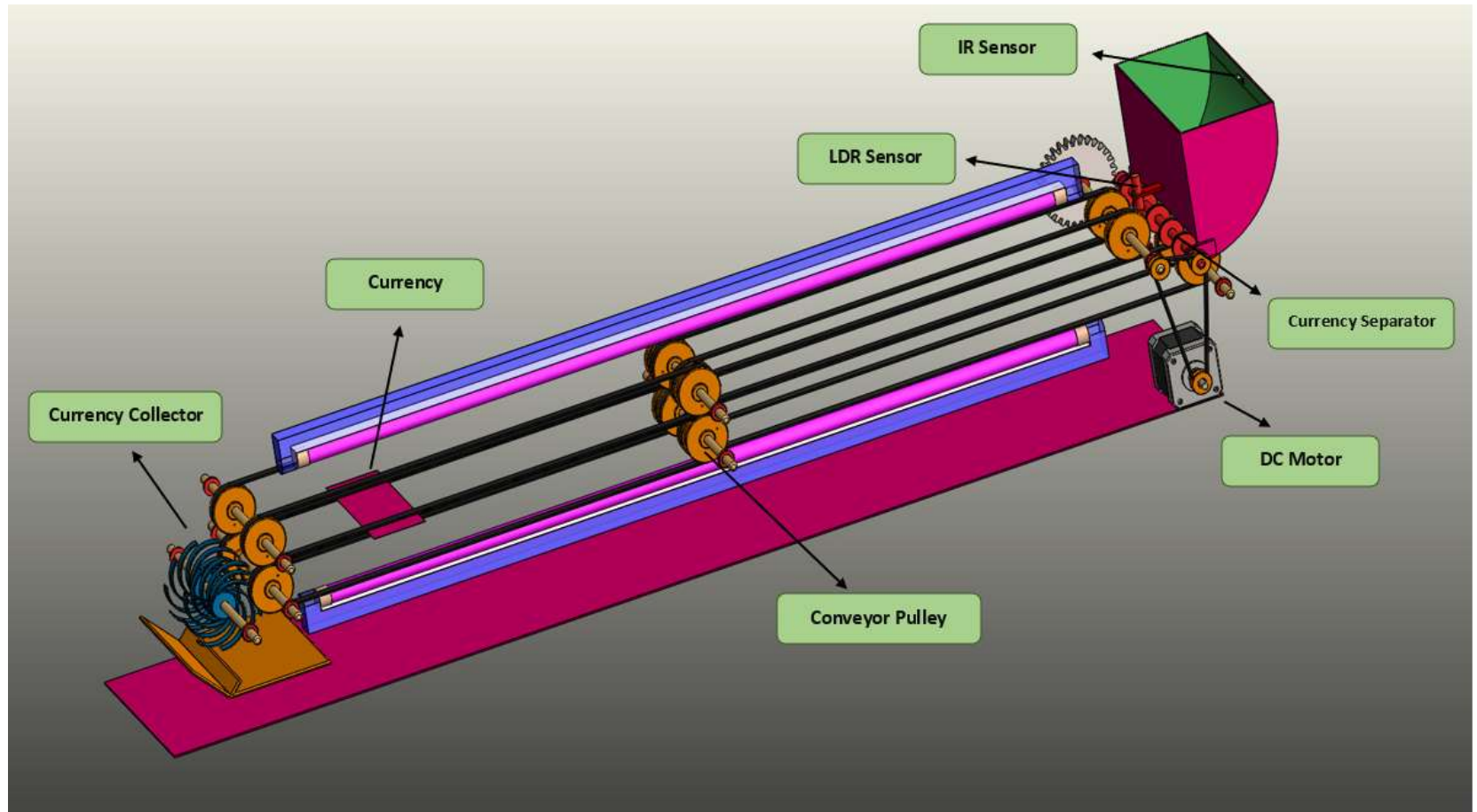


Side View

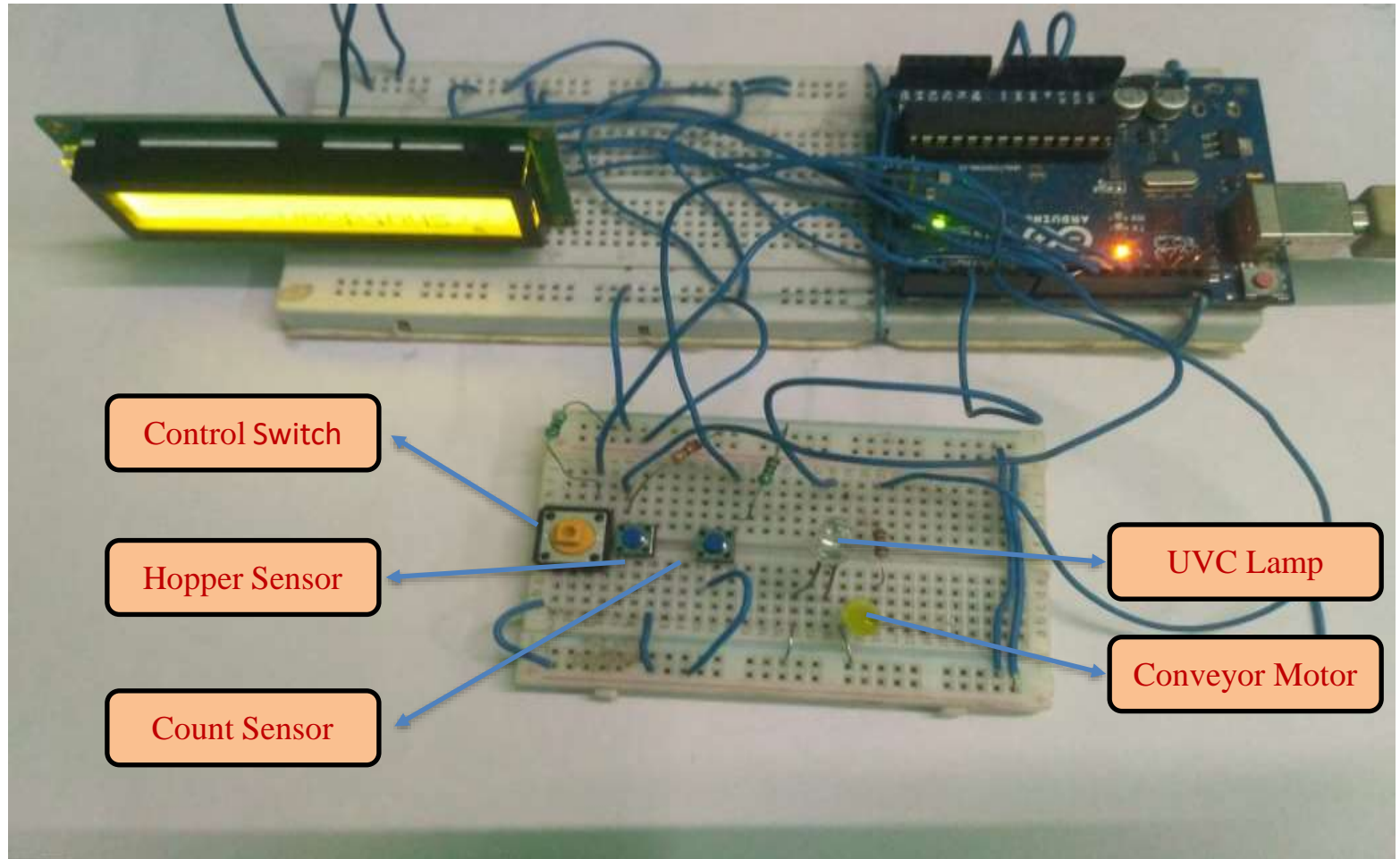
Top View



3D Design



Experimental Set-up



Conclusions

This review summarizes the latest research on the potential of paper currency bills serves as a pathogenic agent lead to the spread of emerging COVID-19. The developed autonomous system incorporates the sterilizing of currency bills during cash counting with the incremental UV dose log reduction to inactivate the microbes. The present invention ensures counting at high speed with high degree of sterilization exclusively designed for Banking sectors.

Future Scope

- ❑ Globally, the automatic counting machine market is expected to have a notable CAGR in the following years.
- ❑ In future, new strains of microbes can be eradicated by updating the UV dose incremental log inactivation of microbes.
- ❑ Furthermore, the advancement with modernistic features can be made in the prototype.



References

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5. Baek M.S. (2016). 'Bill sterilizer equipped with counting machine'. U.S. Patent No. 9,415,124.
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