Operation of electrical appliances in the absence of direct human contact to inhibit the spread of COVID-19

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I. ABSTRACT:

This report explores the prospects of adopting the usage of Infrared Hover Switches (IR Hover Switches), operated in the absence of human contact, to inhibit the spread of coronavirus disease 2019 (COVID-19).

Transmission of the COVID-19 virus has been linked to close contact between individuals and various surfaces in health-care as well as non health-care settings. Moreover, publicly accessible infrastructure is highly vulnerable to an increased spread rate of the disease. Therefore, it is highly desirable to have various commonly used appliances such as light bulbs, fans, elevators and frameworks such as doors, gates, bins operated via no-touch mechanisms. The report justifies the efficacy of one such no-touch mechanism which has been detailed in the context of electric appliances such as fans and light bulbs.

II. PRINCIPLE OF OPERATION:

IR Hover Switches employ infrared light as the medium of communication. The infrared module, on sensing an obstacle for a specified time enables signal transmission to the microcontroller which triggers either an open or a closed circuit based on the output of the former. The same principle is incorporated to activate or deactivate the relay switch.

On the basis of the principle above, appliances could be operated in the absence of direct contact.

III. COMPONENTS REQUIRED:

For an appropriate and effectual operation of IR Hover Switches, the following components are to be incorporated,

- *ATMEGA 32A Microcontroller:* performs the related set of tasks based on the source code programmed.
- *Infrared Sensor Module:* detects the presence of an obstacle placed before the proximity light sensor, thereby generating the output signal to the microcontroller.
- *5V Relay Module (Relay Switch, BC547 Transistor, 1KΩ Resistor):* operates using an electromagnet and acts as a link between the high AC and the low DC voltages.
- *5V AC-DC Power Supply Board:* is the power source for the microcontroller, having stepped down and rectified the 220V AC using transformer and full wave rectifier.
- *Light Emitting Diode:* indicates the ON/ OFF state of the switch to the user.
- *General Circuit Board:* provides the platform to embed the electrical and electronic components.
- *P-N Junction Diode:* ensures one directional flow of current and safety of operation.
- *Housing Unit:* maintains the electric and electronic components intact and free from hazards.
- *Connecting Wires:* links different components, enabling the flow of current.

IV. CONSTRUCTION:

With the various components embedded on to the general circuit board, the IR Hover Switch has the following setup;

a. The output pin of the infrared sensor module is connected to the input pin of the ATMEGA 32A microcontroller. With the output pin of the microcontroller being connected to the base of BC547 transistor via diode and 1KΩ resistor, the collector terminal is linked to the 5V relay.
b. The 220V AC mains supply, which drives the appliance, is connected across the 5V relay. The circuit connections are duplicated for all the infrared sensor modules and the relay switches (refer Fig.1).
c. Power supply, placed across the relay board helps convert 220V AC to 5V DC signal.
d. The components are arranged in a compact manner as depicted in Fig.3 and Fig.4. The housing unit (shown in Fig.2), preferably made of Acrylonitrile Butadiene Styrene (ABS) polymer keeps the electric and electronic setup safe, intact and free from external contamination. The housing unit is secured using two lead screws that run throughout its length.
e. Light emitting diodes that are placed below the switches indicate the ON/OFF states. Fig.5 provides a detailed schematic of the typical arrangement of components of the IR Hover Switch.

V. OPERATION:

- With an obstacle being placed at a certain distance (based on the position of the potentiometer set) for a specified time, the transmitted IR rays reflected from the obstacle is sensed by a photodiode. This output, upon amplification by the comparator is received by the microcontroller.
- The ATMEGA 32A microcontroller is programmed such that it triggers the BC547 transistor. Based on the transistor output, the electromagnet inside the relay contributes to closing or opening the electric circuit by energizing and de-energizing a control coil.
- The movable armature carries out the switching of the contact points to open or close the circuit which contains the 220V AC power supply and the appliance.
- 5V DC power supply to the circuit is provided by the AC-DC power supply board consisting of a step down transformer and a full wave rectifier.
- For regulatory devices, dual relay modules with a combination of parallel resistors serve the purpose of varying the speeds by potential divide.

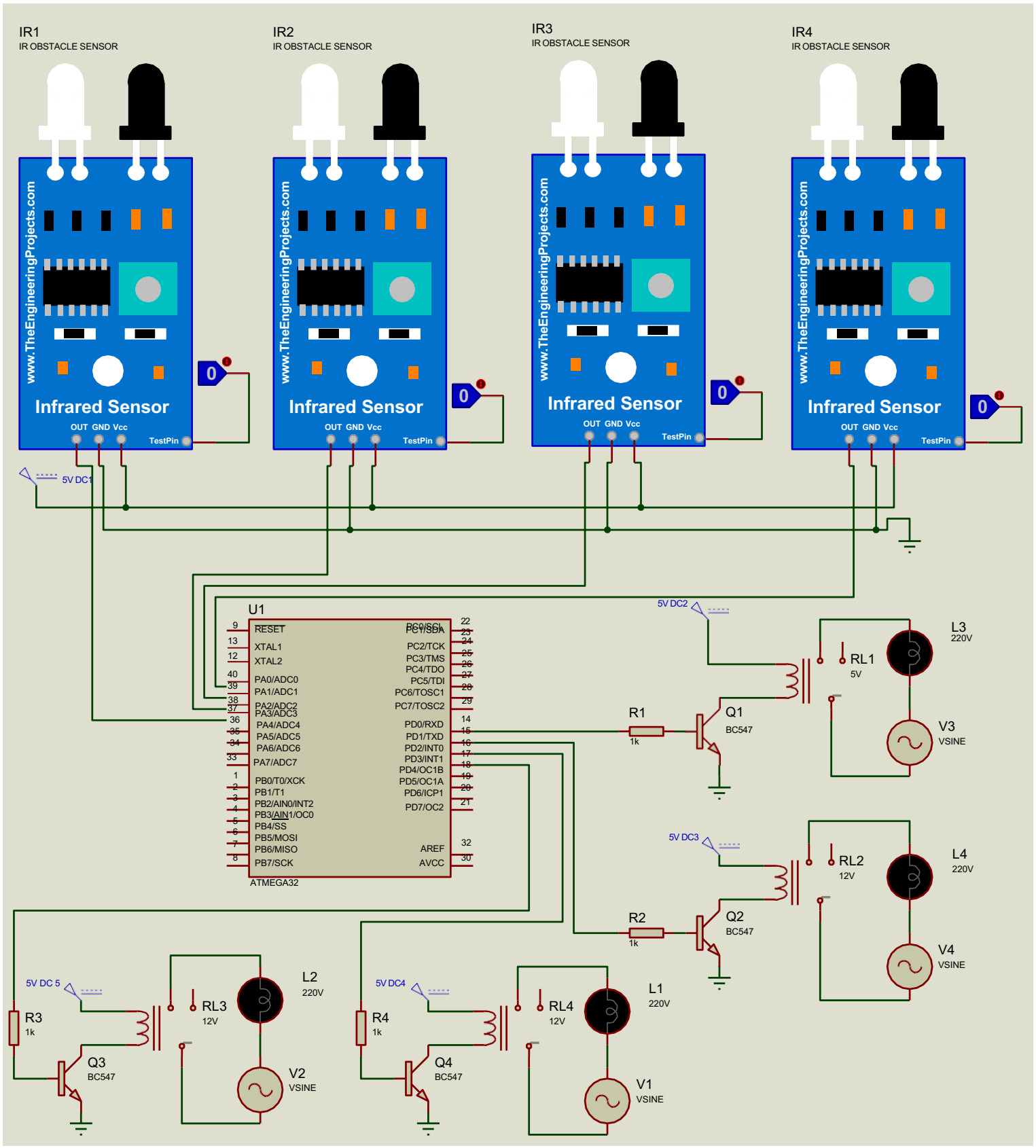

Fig.1: *Electric circuit Diagram for a* ***4-IR Hover Switch Unit***

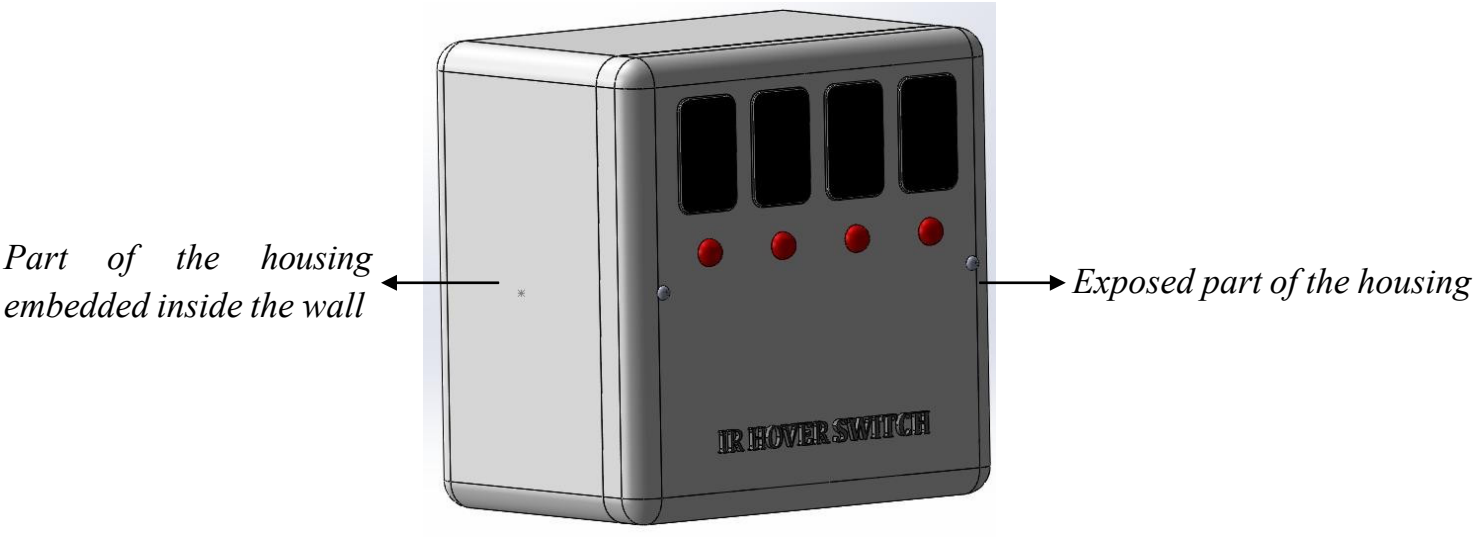

Fig.2: *4-Infrared Hover Switch assembled unit*

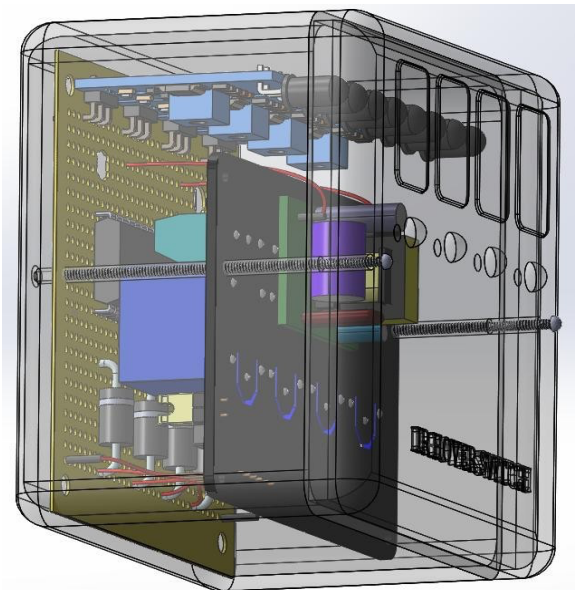

Fig.3: *Transparent view depicting arrangement of various electrical and electronic components*

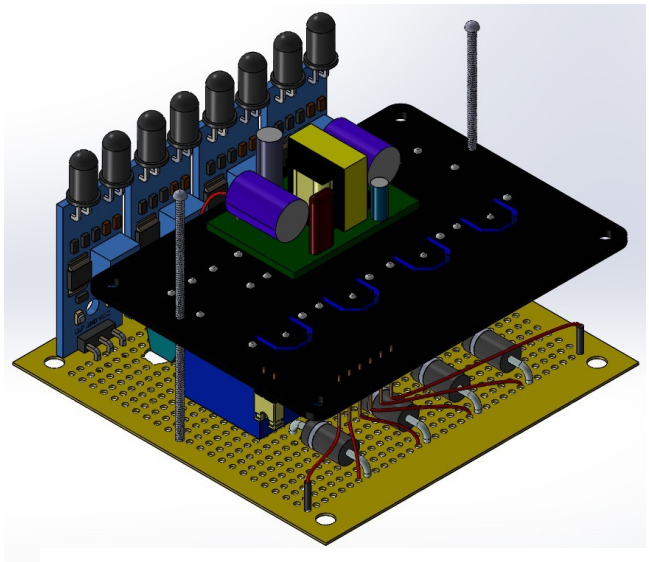

Fig.4: *Internal structure of a 4-Infrared Hover Switch unit*

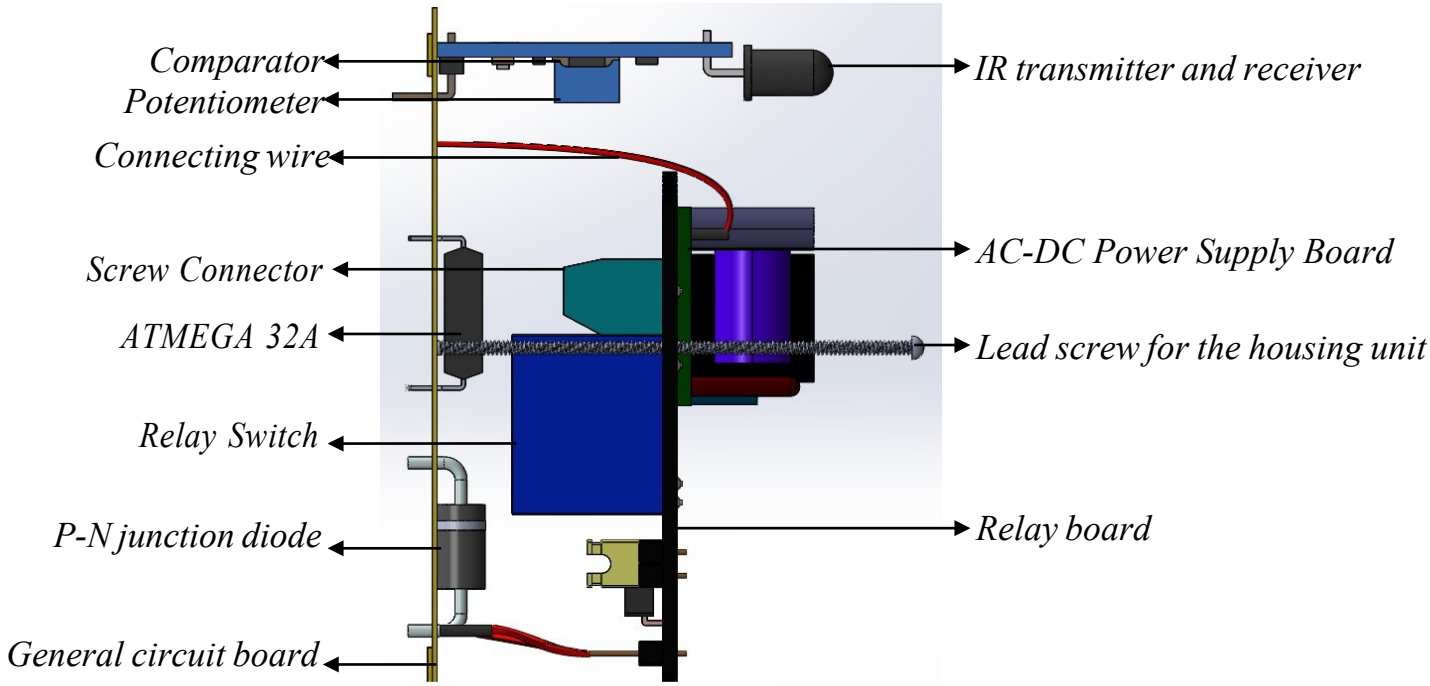

Fig.5: *Schematic diagram of the components of IR Hover Switch*

VI. COST ESTIMATION AND AFFORDABILITY:

ESTIMATED COST BREAKDOWN BASED ON NUMBER OF UNITS REQUIRED								
			4 SWITCH UNIT		6 SWITCH UNIT		8 SWITCH UNIT	
S.NO.	COMPONENT	COST PER UNIT (Rs.)	QTY.	NET COST (Rs.)	QTY.	NET COST (Rs.)	QTY.	NET COST (Rs.)
1	ATMEGA 32A MICROCONTROLLER	150	1	150	1	150	1	150
2	INFRARED SENSOR MODULE	50	4	200	6	300	8	400
6	5V AC-DC POWER SUPPLY BOARD	25	1	25	1	25	1	25
4	CONNECTING WIRES (10)	20	1	20	1	20	1	20
3	LIGHT EMITTING DIODE	2	4	8	6	12	8	16
5	GENERAL CIRCUIT BOARD	—	1	50	1	50	1	100
7	RELAY MODULE	—	1	155	1	244	1	285
8	RESISTORS*	2	—	—	—	—	—	—
9	HEAT SINK*	7	—	—	—	—	—	—
	SUB TOTAL	—	**608**		**801**		**996**	
9	LEAD SCREW	1	2	2	2	2	2	2
10	HOUSING UNIT				TBD			
	GRAND TOTAL				**TBD**			

			10 SWITCH UNIT		12 SWITCH UNIT		REGULATOR UNIT (FAN)	
S.NO.	COMPONENT	COST PER UNIT (Rs.)	QTY.	NET COST (Rs.)	QTY.	NET COST (Rs.)	QTY.	NET COST (Rs.)
1	ATMEGA 32A MICROCONTROLLER	150	1	150	1	150	—	—
2	INFRARED SENSOR MODULE	50	10	500	12	600	—	—
6	5V AC-DC POWER SUPPLY BOARD	25	1	25	1	25	—	—
4	CONNECTING WIRES (10)	20	1	20	1	20	—	—
3	LIGHT EMITTING DIODE	2	10	20	12	24	5	10
5	GENERAL CIRCUIT BOARD	—	1	100	1	100	—	—
7	RELAY MODULE	—	1	374	1	440	2	50
8	RESISTORS*	2	—	—	—	—	4	8
9	HEAT SINK*	7	—	—	—	—	—	7
	SUB TOTAL	—		**1189**		**1359**		**75**
9	LEAD SCREW	1	2	2	2	2	2	2
10	HOUSING UNIT				TBD			
	GRAND TOTAL				**TBD**			

***FOR REGULATORY DEVICES ONLY**

The tabulation of cost estimate of various IR Hover Switch units justifies the reasonability of the product. Moreover, the setup is highly compact, user friendly, easy to install and seems desirable to curb the COVID-19 disease.

VII. APPLICATIONS:

- Switch boards in health-care and non health-care settings
- Elevator buttons
- Control over sanitary appliances
- Regulate opening and closing of doors and gates
- Token systems in public settings like hospitals, reservation offices, banks, etc
- Card swipe machines
- Automated Teller Machines (ATM) to enable contactless transactions