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Kampus Sungai Petani

Faculty of Administrative  
Science and Policy Studies

# i-SPIKE 2021

*Leading An Artificial Innovation In Knowledge, Education And Design*

## **i-SPIKE 2021 INTERNATIONAL EXHIBITION & SYMPOSIUM E-PROCEEDINGS**

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## ARDU-ELECTROCHROMIC FILM FOR HOME SAFETY AND PRIVACY PURPOSE

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### ABSTRACT

The demands for smart devices are increasing exponentially nowadays. This project presents the invention of a new, low cost, and user-controlled electrochromic film device for home safety and privacy purposes. The development of this system focuses on windows where electrochromism materials as a film had been layered for the safety and privacy plan. The film material was chosen instead of mirror due to its cost effectiveness, convenient properties which are more versatile, and installable to any pre-existing glass available. The excessive exposure of UV radiation over 15 minutes causes acute and chronic long-term skin effects. Meanwhile, high cost in cutting precise glass appliances due to high volume of heat trapped during daylight causes the application of this device to be crucial. This invention is equipped with IoT (Internet of Things) which helps users to control it remotely via Blynk Apps in smartphones and displaying all the sensor's output. The system comprises Arduino UNO as main controller, NodeMCU ESP8266 for IoT platform, solar battery as a power source, UV sensor together with PIR sensor to enhance safety purpose and DHT11 for monitoring temperature and humidity. The efficiency of the system was evaluated by measuring the changes in solar radiation and temperature in between inside/outside of the system. This simple, reliable, and economically smart Ardu-electrochromic film system is a new potential management device preventing excessive UV lighting in houses, promising privacy and safety as well.

**Keywords:** electrochromic film, UV radiation, UV sensor, automation, IoT

### INTRODUCTION

Smart materials are materials that sense and react to environmental conditions or stimuli such as mechanical, chemical, electrical, or magnetic signals (Bandyopadhyay & Sinha Ray, 2012). In the construction industry, glass is one of the main elements used by architects and engineers for houses and buildings leading to a high demand from manufacturers for construction companies. According to Ho Sai Woo, the chairman of the Malaysia Glass Association (MGA), the glass industry is booming with a RM3 billion turnover for both glass manufacturing and processing streams of the industry (Zieman, 2013). One type of smart material glass is the electrochromic glass. Electrochromic materials are materials that change their optical properties when a voltage is applied across it (Granqvist, 2006). Normal transparent glass does not assist in keeping privacy and safety. It is also incapable in blocking the UV radiation from the sunlight and facing high price which requires individual installation which increases

construction cost (Switchable Smart Film vs Switchable Smart Glass, 2017). According to NOAA's Climate Prediction Center (CPC), January 2020 had a temperature departure of 1.14°C, which is 2.05°F above the 20th century average and the highest surface temperature of the Earth's land and sea in 141 years (Global Climate Report - February 2020, 2020). Meanwhile, the Meteorological Department stated that Malaysia's UV index reading could reach 15 in the afternoon on a clear day (Medical And Editorial Content Team, 2019).

Dermatologist Dr Nurashikin Ahmad said that long exposure to extreme UV radiation causes acute and chronic long-term skin effects. People with sensitive skin experience itchiness and sun burns while its long-term effect leads to photo-ageing effects like wrinkles or skin cancer (“UV Level Now Extreme,” 2018).

Thus, a solution has been devised to develop a prototype of a smart house by using electrochromic film (Couput et al., 1992) (Green, 1997) to control the amount of UV light that passes through the house/building by providing safety and privacy as well to the residents. Electrochromic film was chosen instead of electrochromic mirror for its cost-effectiveness with much lower price, convenient properties which are more versatile, and installable to any pre-existing glass available. To achieve the intention of the project, three steps were designed. At first, an Arduino based system powered by a solar source was developed. Next, solar battery charger for the ardu-electrochromic film device was constructed and lastly, the evolution of an electrochromic film device that is remotely controlled by Arduino via Blynk Apps. The project focuses on the development of the electrochromic film to be attached in houses. Electrochromic film was chosen instead of electrochromic mirror due to its stick-on concept and ability to change its state from transparent to opaque. The efficiency of the electrochromic film was measured experimentally at different numbers of voltages. The size of the electrochromic film was estimated to be about 15cm x 10cm. Solar panel with a battery charger was implemented as the power source of the project. By embedding an infrared (IR) sensor to identify the motion of surrounding, ultraviolet (UV) sensor to measure the amount of UV light, DHT11 for monitoring temperature and humidity, this system not only fosters a privacy plan but safety as well.

## METHODOLOGY

The procedures that were applied in the process were presented in the form of a block diagram.

**Table 1:** The whole project’s methodology

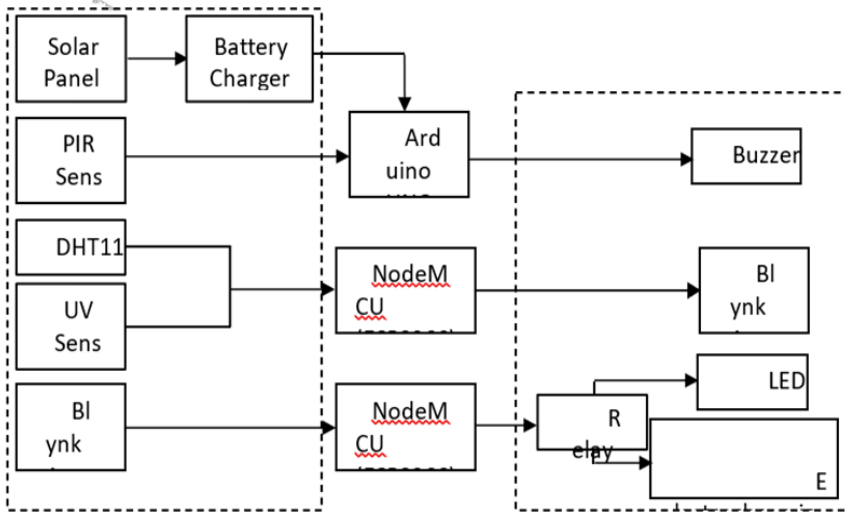
Hardware Implementation	NodeMCU (ESP8266)
	Arduino UNO
Software Implementation	Blynk Application
	Arduino IDE
Measuring Implementation	UV Sensor
	PIR Sensor
	DHT11

### Block Diagram of the Device

The block diagram of the device consists of five separate parts combined into one system to be



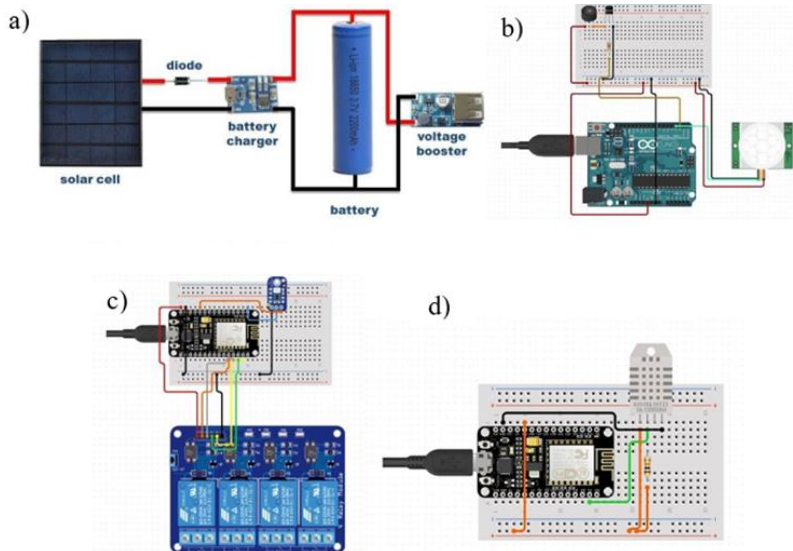
constructed as one completed device. It consists of solar battery charger, PIR sensor (Ada, 2020), DHT11, UV sensor (Instruments, 2013) and smart control as shown in Figure 1.



**Figure 1:** Block diagram for the ardu-electrochromic film device

### Circuit Diagram of the Device

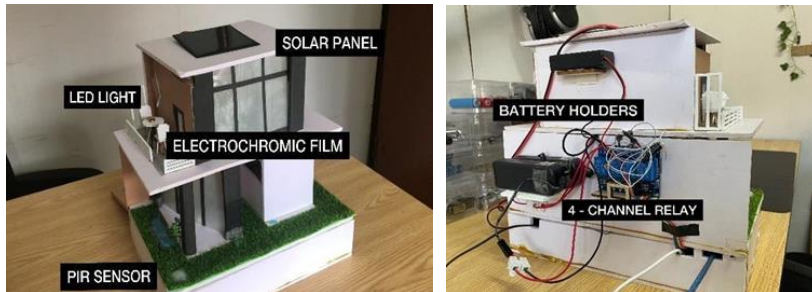
The circuit diagram of the device consists of four parts: The solar battery charger, security alarm, lights & film control and temperature and humidity monitoring. The security alarm uses Arduino Uno as the controller meanwhile ESP8266 used for the lights & film control and temperature humidity monitoring.



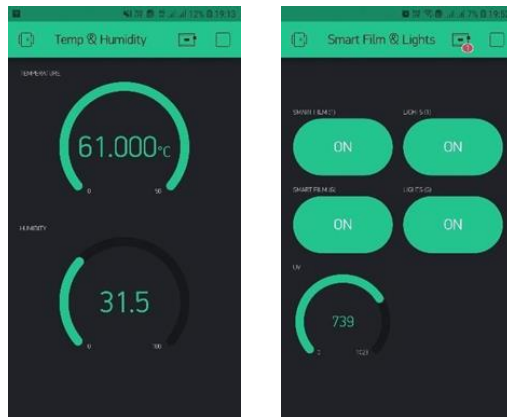
**Figure 2:** Circuit diagram of the device (a) solar battery charger (b) security alarm (c) lights & film control (d) temperature & humidity monitoring

## RESULT AND DISCUSSION

In this section, experiments were conducted to investigate the efficiency of the solar battery charger and the efficiency of the electrochromic film.



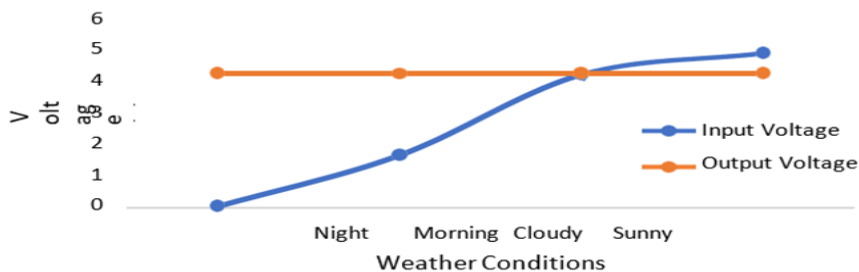
**Figure 3:** The smart house prototype (a) Front view (b) Back view



**Figure 4:** Electrochromic film control, UV light, temperature, and humidity monitoring in the Blynk application

### A) The efficiency of the solar battery charger

The efficiency of the solar battery charger was measured and calculated by measuring the voltages, currents and calculating its power (Guo et al., 2010). Figure 5 shows the consistent amount of voltage captured from the solar battery charger at different weather conditions.



**Figure 5:** Graph of voltage (V) against different weather conditions.

B) The efficiency of the electrochromic film

The efficiency of the electrochromic film was determined by measuring the amount of sunlight passing through the device when the electrochromic film was at transparent and opaque states by using a pyranometer.

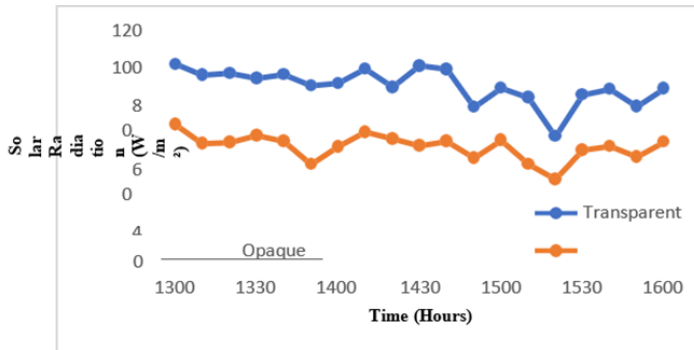


Figure 6: Graph of solar radiation at transparent and opaque states against time

**CONCLUSION**

The ardu-electrochromic film system was successfully developed, and the device was validated electronically by a smart house prototype. Based on the data collected, the ardu-electrochromic film device was proven to block the amount of UV light directly entering a house/building by 62% efficiency. In addition, the solar battery charger showed a constant and efficient amount of power to the ardu-electrochromic film device regardless of time and weather conditions. All the sensor’s systems also exhibited good functionality. Thus, the intention of this system to provide privacy and safety was successfully demonstrated.

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