Remote Holder Design for Controlling the Air Conditioner System

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Abstract: Energy usage raterisesas population and economic increase. The unrenewable energy sources decrease and the price increases. Even alternative energy sources are suggested, the product is limited. One of ways to avoid energy insufficiency is to minimize home appliances energy consumptions. Some suggestions have been proposed but ideas should becontinuously explored as human life depends on energy availability. Despite air conditioning automatic control system to minimize energy consumption exists, this articledesigned a remote holder to place any remote on it so that the device controls and drives remote based on human existence in the room. The designed device is tested during working time and the results proof that the designed device decreasesaboutone third of energy usage.

1 INTRODUCTION

The survey show that the energy demand of daily human life grows significantly each year (Fitriana *et al.*, 2017), where cooling and lighting devices consume the most. This fact becomes more obvious in tropical country where the humidity and temperature are quite high, while room temperature requires air conditioner to decrease it. The Indonesian standard mentioned that comfortable temperature is about 22°C to 26°C (Nasional, 2001). Such temperature is lower that the outdoor temperature in most tropical country, so that the air conditioner is employed to adjust it.

The energy consumption this cooling device may increase if suggested maintenance is ignored. Poor interior plan also contributes to energy waste. Human behaviour often makes it worse.

Human awareness is very important on applying energy reduction policy. However, discipline is often to be a challenge that hardly overcome. Therefore, human cannot be counted on. The automatic control system is the expected solution. Passive infrared sensor is the stunning invention that is able to detect human presence. Many solutions (Bakhtiar, B., & Suherman, 2015; Harikrishnan, R., & Sivagami, 2017) employ this sensor to control energy usage. Some air conditioner systems have been equipped by this technology, that is able to detect and optimize how many people within the controlled room so that suitable temperature can be offered accordingly (Ahamed *et al.*, 2016).

However, most the installed cooling systems are not prepared for this technology, mainly for cost effective reason. Additional controller may be useful. Existing works such as Zeebaree (2014), offered a device to automatically control the temperature.The remote control design is also the object of some proposed solutions (Aketa, Y., & Yokoyama, no date; Kawai et.al, 2015). Likewise, PIR was proposed by other researchers to manage energy reduction (Harikrishnan, R., & Sivagami, 2017).

This article reports the PIR based remote holder to be used for any kind of remote so that no much changes on system is required. The proposed remote holder may be mounted on the wall where remote is easily accessed and human presence is covered.

2 DESIGN AND EVALUATION

2.1 Electronic Design

In order to implement the remote holder, the following electronic components are collected and employed. A transformer along with diodes and an integrated circuit regulator are employed to change thepower outlet to feeding voltage of 12 VDC. A small solenoid is employed to mechanically push the remote button.

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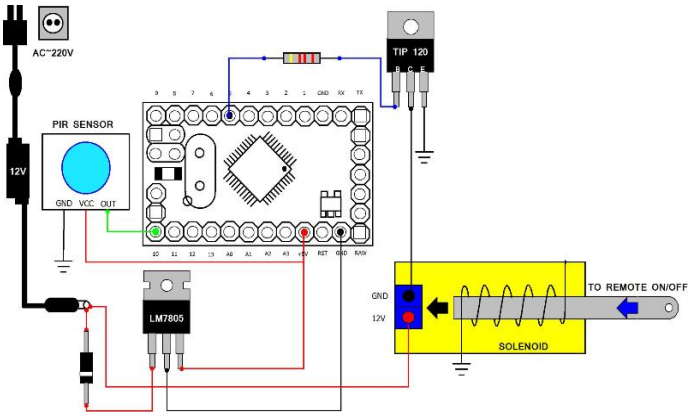

Figure1.The designed electronic circuits

In order to do that, A PIR sensor is employed to detect human. All circuit is controlled by an integrated microcontroller module: Arduino. All circuit is arranged as depicted in Figure 1.

2.2 Programming Plan

The programmed software is through Arduino scratch. The initial OFF state represents that AC is off. PIR sensor is periodically evaluated so that human presence can be detected. When human enters the room, microcontroller order solenoid arm to push the remote ON button so that AC works. The opposite condition also employs PIR and arduino.

2.3 Mechanical Design

The mechanical design is drawn as in Figure 2. This initial plan show that mechanical relay takes the large portion of the mechanical design. However, size reduction is possible by using micro switch.

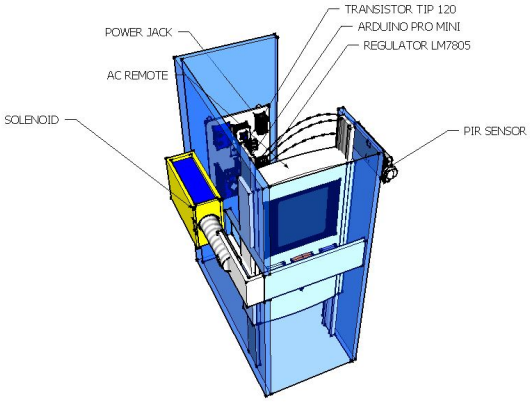

Figure 2. Mechanical design

2.4 System Evaluation

In order to evaluate the impact of the designed device to reduce the AC energy consumption, the following assessment is applied. The human detection capability is mapped as in Figure 3 and Figure 4.

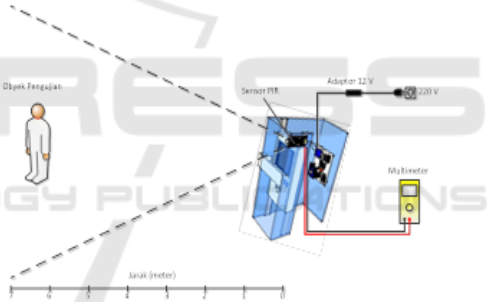

Figure 3. Human Existence Test

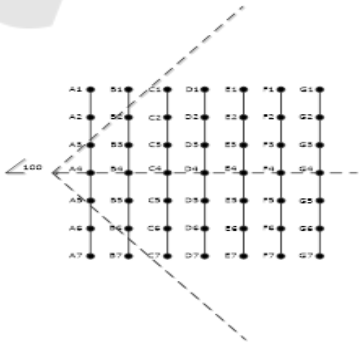

Figure 4. Detection Area

The energy reduction assessment is assessed by plotting the same scenario for an automatic AC, ordinary AC and ordinary AC with the designed device. The observation time is planned to be similar for each experiment.

3 EVALUATION RESULTS

The human presence test is fully successful as all positions give positive detection (Table 1).The circuit tests on the other handproduce varied outcomes. The hardware calibration is performed about 1000 milliseconds before the human detection performed. The scenario is plotted twice for 50 times human detection tests with average detection failure rate of 6%.

Table 1. Human Presence Tests

Spot location	Outcomes	Spot location	Outcomes
A1	LOW	D1	HIGH
A2	LOW	D2	HIGH
A3	HIGH	D3	HIGH
A4	HIGH	D4	HIGH
A5	HIGH	D5	HIGH
A6	LOW	D6	HIGH
A7	LOW	D7	HIGH
B1	LOW	E1	LOW
B2	HIGH	E2	LOW
B3	HIGH	E3	HIGH
B4	HIGH	E4	HIGH
B5	HIGH	E5	HIGH
B6	HIGH	E6	LOW
B7	LOW	E7	LOW
C1	HIGH	F1	LOW
C2	HIGH	F2	LOW
C3	HIGH	F3	LOW
C4	HIGH	F4	LOW
C5	HIGH	F5	LOW
C6	HIGH	F6	LOW
C7	HIGH	F7	LOW

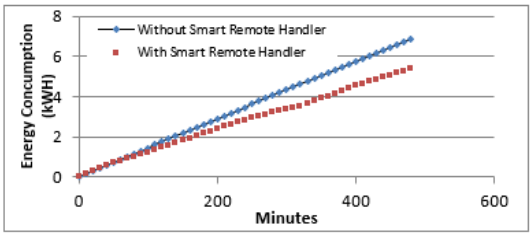

Figure 5. Energy usage pattern

Location spots with distances higher than 5m is not detected as in F and G spots, A7, A2, A6 and A1. The consumption test shows increasing total energy consumption over time as depicted in Figure 5. When compared to a conventional AC with and without the designed device, the average energy consumption decreases almost 20%. The average temperature is more than 3% lower (Figure 6).

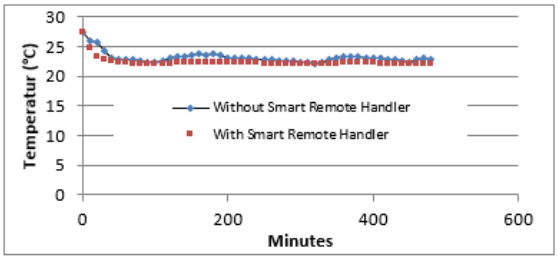

Figure 6. Room temperature comparison

The next evaluation is to compare the conventional AC equipped by the designed device and the automatic AC. The results are plotted in Figure 7. The average temperature of the conventional AC equipped by the proposed device ismore than 5% colder than the automatic AC.

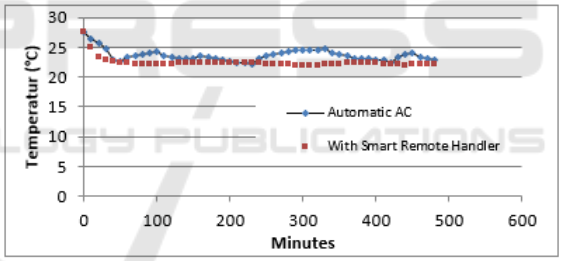

Figure 7. Automatic AC comparison

Meanwhile, the amount of the consumed energy for each experiment is recorded in Table 2, where clearly described that the device is able to decrease energy consumption 21% lower than the automatic one and about 32% to standard air conditioner system.

Table 2. Energy consumption records

System	Energy in kWH
ConventionalAC	6.8483
Automatic AC	5.4106
ConventionalAC plus device	4.6365

4 CONCLUSIONS

In conclusion, this paper has proposed the smart remote holder and the experiment has revealed that the device is successfully decreasing energy usage on air conditioning system. The standard AC equipped with the proposed device is reduced about 32%, and 21% lower than the automatic system. Furthermore, the device is successful in maintaining lower room temperature. There has been failure detection if distance of human presence is longer than 5 m, therefore, multiple sensors may be applied in future work.

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