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An AI based Self-cleaning System for Split ACs

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Abstract— Split air conditioners are extensively used for cooling and maintaining indoor comfort levels in various environments. However, the accumulation of dust, dirt, and microbial contaminants within this system can lead to reduce efficiency, increased energy consumption, and degraded air quality. This research paper presents a novel Artificial Intelligence (AI) based self-cleaning system for split air conditioners (AC), aiming to enhance performance, minimize manual intervention, and ensure healthier indoor environments. This system can measure the distance level of airborne dust particles and then operate servo mechanism according to the distance level of dust. The proposed system utilizes AI algorithms, Arduino Uno, HC-SR04 Ultrasonic sensor networks, LM016L LCD display and servo mechanisms to detect, analyze, and efficiently clean the internal components of their split air conditioners. The suggested automated cleaning system for split air conditioners makes use of the Autoregressive Integrated Moving Average (ARIMA) model to model and anticipate dust collection. The AI technique assist to operate cleaning system based on the past data and decision making.

Index Terms— ARIMA, Split air conditioners, Artificial Intelligence, Arduino Uno, HC-SR04 Ultrasonic sensor networks, Servo mechanism, Indoor air quality.

I. INTRODUCTION

In recent years, the demand for efficient and environment friendly cooling solutions has been on the rise. One significant advancement in this field is the development of an AI-based self-cleaning system for split air conditioners. This innovative technology aims to enhance the performance, energy efficiency, and longevity of air conditioning units while reducing maintenance efforts and costs. The AI-based self-cleaning system for split air conditioners incorporates cutting-edge artificial intelligence algorithms and sensors to monitor and optimize the cleaning process. Traditional split air conditioners accumulate dust, dirt, and other pollutants on their filters and coils over time leading to decreased cooling efficiency and increased energy consumption. However, with the new self-cleaning system, the split air conditioners are equipped with intelligent sensors that detect the distance level of dust buildup and trigger the cleaning system automatically and saving both time and effort for users. By leveraging the power of artificial intelligence, this technology promises a cleaner, more efficient, and more sustainable future for cooling systems.

II. REQUIRED COMPONENTS AND CIRCUIT DIAGRAM

Various components are required to build this project. The list is given below.

Table I: Required Components

Sl. No.	Component	Description
01.	Microcontroller Board	Arduino Uno Board
02.	Ultrasonic Sensors	HC-SR04 (Two nos.)
03.	LCD Display	LM016L (02 rows, 16 col.)
04.	DC Servo motor	Typical 5V servomotor for Arduino boards. (02 nos.)
05.	Potentiometer	100 ohms pot (03 nos.)

All these components are shown in figure 1.

a. Arduino UNO

b. Potentiometer

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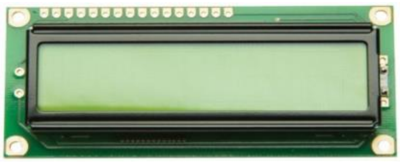
c. Ultrasonic Sensor

d. DC Servomotor



e. LCD Display

Figure 1: Required Components

2.1 Arduino UNO Board

Arduino uno is a microcontroller unit which will operate the servo motors according to the distance level sensed by HC-SR04 ultrasonic sensor. The ultrasonic sensors detect the distance level of dust in the chamber of air conditioners and send this information digitally to the microcontroller unit and microcontroller controls the speed and angle of servo motors automatically [3].

2.2 Ultrasonic Sensors (HC-SR04)

An HC-SR04 ultrasonic sensor is a device that uses sound waves with frequencies higher than the human audible range to detect objects or measure distance level. It works on the principle of sending out high-frequency sound waves and measuring the time it takes for the sound waves to bounce back after hitting an object. HC-SR04 Ultrasonic sensor are commonly used for various applications such as distance measurement, object detection, collision avoidance, level sensing, and robotics. They offer advantages like non-contact operation, wide detection range, and high accuracy [4].

2.3 DC Servomotors

The servo motors are used for wiper movement for dust removal. The motor used here has three terminals: Power, Ground, and Signal. Power and ground are conneced to +5v supply and Signal terminal is connected to the microcontroller unit for the receiving of the data [5].

2.4 LCD Display

It includes 16 columns and 2 rows, so it can display 32 characters. Each character is made with 5 × 7 LCD dots [6].

2.5 Potentiometers

The Potentiometer is a variable resistance which provides variable test voltages to the test pin of ultrasonic sensor. It has three terminals. One potentiometer is used for LCD display.

III. METHODOLOGY

In this proposed system, ultrasonic sensors HSCR-04 are used for sensing of distance level in the form of movement of dust particle. Here potentiometers are used to simulate the dust level as variable input test supply to the sensor via change in its resistance value. The trigger and echo pins of sensor are connected to the Arduino uno and the output pin of Arduino uno is connected to the Servo mechanism. The servo motor can turn 90 degrees from either direction form its neutral position. The code for the sensor with Arduino is written in Arduino programming language (C/ C++) and is compiled using Arduino IDE. For the output analysis we use a LM016L LCD display.

The overall procedure is given in flow chart of figure 2. As per flow chart, the Arduino receives the dust level input from two ultrasonic sensors. On the basis of dust levels, Arduino determines whether dust has to be cleaned or not. If dust is more, then it gives command to servo motors to move the cleaner for dust removal. The several test cases are generated with input and output and this data is used for modelling ARIMA model [1, 2]. After sufficient amount of training data generation and completion of AI model training, the AI model takes control and gives command to servo motors directly for AC cleaning depending on the input dust levels.

In this case, the speed of servo motors is also depending on dust levels. If dust is more then, motors are run with more speed. If dust level is less then motors run with slower speed. This distinct feature makes the proposed system intelligent.

IV. DUST ACCUMULATION MODELLING USING ARIMA

4.1 Autoregressive (AR) Component

The AR component takes into account the correlation between the levels of dust deposition that are present today and those that were present in the past. This explains trends and patterns in the accumulation of dust throughout time. The order of the autoregressive terms, represented by the letter "p," indicates it.

$$AR(p): Dust_t = c + \phi_1 \times Dust_{t-1} + \phi_2 \times Dust_{t-2} + \cdots + \phi_p \times Dust_{t-p} + \varepsilon_t \quad \text{-------- (i)}$$

Where:
$Dust_t$ is the dust accumulation level at time t.
c is a constant term.
$\phi_1, \phi_2, \dots, \phi_p$ are autoregressive coefficients.
ε_t is the prediction error at time t.

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4.2 Integrated (I) Component

In order to attain stationarity, the I component focuses on differencing the data. The statistical characteristics of the data, such as mean and variance, must be stationary in order for them to remain constant across time. 'd' indicates the order of differencing.

$I(d): \Delta Dust_t = Dust_t - Dust_{t-d}$-------- (ii)

Where:
$\Delta Dust_t$ is the differenced dust accumulation at time t.
d is the order of differencing.

4.3 Moving Average (MA) Component

The MA component evaluates the connection between the present dust build up and the remaining mistakes from earlier forecasts. This aids in capturing transient data variations. The order of the moving average terms is indicated by the letter "q" to identify it.

$MA(q): Dust_t = \mu + \varepsilon_t + \theta_1 \times \varepsilon_{t-1} + \theta_2 \times \varepsilon_{t-2} + \cdots + \theta_q \times \varepsilon_{t-q}$ --------- (iii)

Where:
μ is the average dust accumulation.
ε_t is the prediction error at time t.
$\theta_1, \theta_2, \ldots, \theta_q$ are moving average coefficients.

4.4 Final ARIMA Model

These elements are combined to form the full ARIMA model. An ARIMA model containing p autoregressive terms, d differencing, and q moving average terms is represented by the notation $ARIMA\ (p, d, q)$.

$ARIMA(p, d, q): \Delta Dust_t = c + \phi_1 \times \Delta Dust_{t-1} + \phi_2 \times \Delta Dust_{t-2} + \cdots + \phi_p \times \Delta Dust_{t-p} + \theta_1 \times \varepsilon_{t-1} + \theta_2 \times \varepsilon_{t-2} + \cdots + \theta_q \times \varepsilon_{t-q}$ --------- *(iv)*

Where:
$\Delta Dust_t$ is the differenced dust accumulation at time t.
ε_t is the prediction error at time t.

The proposed methodology is burnt on the controller which helps the system to make decision. The cleaning system makes the most of its schedule by anticipating when dust accumulation is likely to happen.

The circuit implementation is also shown in figure 3.

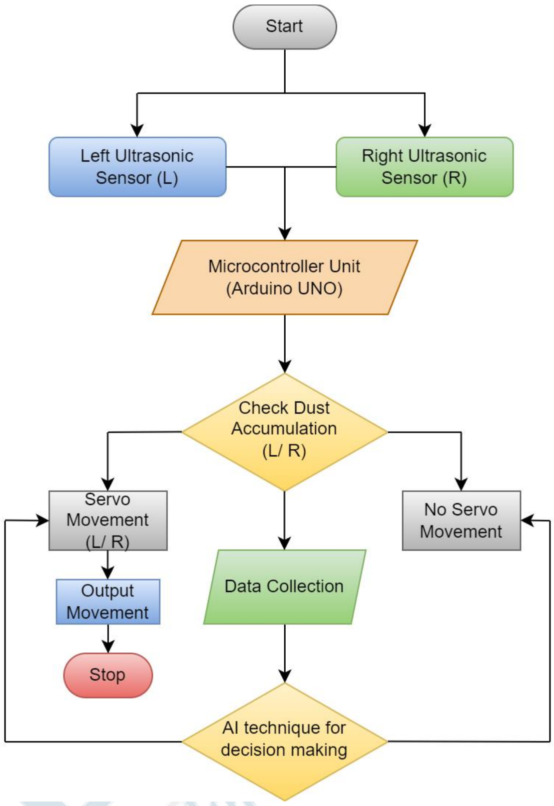

Figure 2: Process Flow Chart

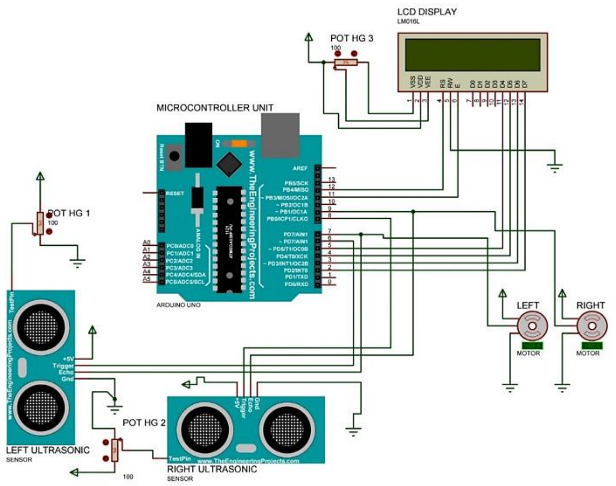

Figure 3: Complete connection with Arduino, HC-SR04 Ultrasonic Sensor and Servomotors

V. SIMULATION OUTCOMES

This system is built with all suggested hardware components and input output test data is generated. With this data, an ARIMA model is trained. The simulation result of this proposed system is shown in figure 4 and table 2.

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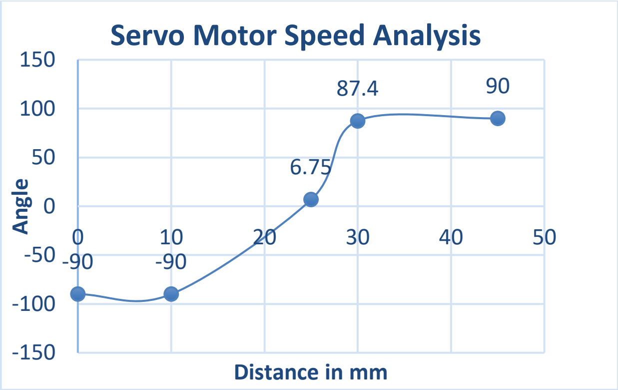

Figure 4: Servomotor movement with dust level

Table II: Servomotor movement with dust level

Dust level (mm)		Motor Movement (Degree)
Left Sensor	Right Sensor	
< 1	< 1	0
< 10	< 10	0
>10	>10	> 0
= 25	= 25	6.75
= 30	= 30	87.4
= 45	= 45	90

VI. CONCLUSION

The AI-based self-cleaning system for split air conditioners presents a significant advancement in air conditioning technology. It offers several benefits that enhance the overall performance, efficiency, and user experience of split air conditioners. The An AI-based self-cleaning system automates the cleaning process, eliminating the need for manual intervention. This not only saves time and effort but also ensures that the cleaning is carried out consistently and efficiently. The AI system can schedule and perform cleaning tasks based on real-time data, such as usage patterns, environmental conditions, and air quality measurements. ARIMA model is used to predict the dust accumulation and make optimal cleaning schedule automatically. With its ability to intelligently monitor and clean the system's components, the AI system ensures optimal functioning, prolongs the lifespan of the air conditioner, and enhances the overall comfort and well-being of users.

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