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E-mail:ambidex@takaza.id



Automatic Motorcycle Oil Suitability Checking System Based on Color and Viscosity Parameters Using the Rule Based System Method

Khaidri Ralphil
Program Studi Teknologi Informasi Fakultas Ilmu Komputer Dan Teknologi Informasi
Universitas Muhammadiyah Sumatera Utara
Corresponding Author e-mail : khaidrirapilnew@gmail.com

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Abstract :*The decline in the quality of automatic motorcycle oil can be identified through changes in color and viscosity, but visual assessment does not provide sufficient objective information. This study aims to design a system to check the suitability of automatic motorcycle oil based on color and viscosity parameters using a Rule Based System. This study is a system design study with stages of design, testing, evaluation, and prototype improvement. The test materials consist of four types of automatic motorcycle oil, namely Motul Scooter Expert LE 10W-40, Motul GP Matic 10W-40, Shell Advance 10W-30, and AHM Oil MPX2, while the number of populations and sampling techniques are not specifically stated in the manuscript. The instrument consists of ESP8266, TCS3200 sensor, waterflow meter, and 16×2 LCD. Data were analyzed using IF-THEN rules. The test results show that the system is able to read the color and flow of oil, classify conditions into very suitable, suitable, and unsuitable, display the results on the LCD, and send data to the server for real-time monitoring. In conclusion, the system can be used to help check oil conditions more measurably based on a combination of color and viscosity.*

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Introduction

Motorcycles are two-wheeled vehicles widely used in daily activities and have various engine components that work by receiving heat, chemical, frictional, pressure, and other mechanical loads (Ariyono et al., 2019; Dayera et al., 2023). Automatic motorcycles are one type of vehicle that is widely used due to their ease of operation and comfort, allowing engine components to work continuously. One important component that supports engine performance is oil, which functions as a lubricant and helps cool the engine. During use, oil can become dirty and experience a decline in quality, which can affect engine performance. This condition can be recognized by several signs, such as mileage, changes in oil

color, engine sound, and oil volume (Alfriana et al., 2024). Over time, the condition of vehicle components can also change, so routine maintenance is required to keep the vehicle in prime condition (Arganata et al., 2017; Sujanarko & Jamaaluddin, 2022).

Oil changes need to be considered because the oil change time can vary from vehicle to vehicle, even for the same brand and type. This is influenced by the traffic conditions experienced by the vehicle (Ms et al., 2021). One important characteristic in determining oil condition is viscosity, which is the level of viscosity of a fluid related to the frictional force between its constituent molecules (Rongcai et al., 2024). Changes in viscosity can affect the oil's ability to form a lubricating layer between moving engine components. Therefore, oil condition cannot be assessed solely based on color changes, as this assessment does not provide an adequate picture of viscosity. A combination of color and viscosity parameters is necessary for a more objective evaluation of automatic motorcycle oil condition.

The problem in determining the suitability of automatic motorcycle oil is related to the general public's continued assessment of oil quality primarily based on visual inspection. While color changes can be a sign of changes in oil condition, assessments based solely on color fail to consider the oil's viscosity. Viscosity changes are linked to lubrication effectiveness and engine performance. This situation highlights the need for a system capable of combining color and viscosity information to provide a more measurable basis for assessing oil suitability.

The next problem is the need for a decision-making method that can process color and viscosity parameters in a logical and structured manner. These parameters have specific value limits that can be used to represent oil conditions, so a method capable of linking sensor readings to oil suitability categories is needed. A Rule-Based System was chosen because it can represent mechanical knowledge in the form of simple rules. The relationship between color changes, viscosity changes, and oil suitability conditions can be formulated through easy-to-implement rules that do not require complex data learning processes. The implementation of a Rule-Based System is also expected to increase system effectiveness and efficiency and provide a rapid response in handling information used in the decision-making process (Supratman et al., 2024).

This problem is also related to the need for a device that can read parameters directly and process them into easily understood information. This study uses the ESP8266 as a data processing center and Internet of Things (IoT)-based communication media, a TCS3200 sensor to detect oil color changes, and a waterflow meter to read flow changes that represent viscosity levels. Data from both sensors is then processed using predetermined rules and the results are displayed via a 16x2 LCD so that the oil condition can be known directly. With this design, the system is aimed at reducing dependence on visual assessments and producing a more objective assessment of oil suitability.

Based on these problems, this study aims to design a system for checking the suitability of automatic motorcycle oil based on color and viscosity parameters in a measurable and regular manner. This study is also directed to provide a solution for users who have been assessing oil quality through sight by presenting an examination that considers color and viscosity levels. The urgency of this research lies in the need for a more objective assessment of oil conditions so that it can help determine the time for oil changes. The novelty of this research lies in the application of a Rule Based System to process a combination of color and viscosity parameters in automatic motorcycle oil using a TCS3200 sensor and a waterflow meter integrated with ESP8266 and an Internet of Things-based monitoring system. Previous research summarized in this thesis used an approach such as Naïve Bayes and produced a simpler classification, while this study develops rule-based decisions aimed at assessing oil conditions in a step-by-step manner that is easy for users to understand.

Method

This research is a system design study that applies a Rule-Based System to determine the usability of automatic motorcycle oil based on color and viscosity parameters. The system was developed through iterative stages of design, testing, evaluation, and prototype refinement.

The research instrument consisted of an ESP8266, a TCS3200 color sensor, a waterflow meter, a 16x2 LCD, and other supporting components. Color and viscosity data were analyzed using IF-THEN rules in a Rule-Based System to determine the oil's suitability category. The rule-based system was used because it can process parameters in a structured manner and provide decisions based on predetermined value limits (Supratman et al., 2024).

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The study used automatic motorcycle oil as the system testing material. The types of oil used included Motul Scooter Expert LE 10W-40, Motul GP Matic 10W-40, Shell Advance 10W-30, and AHM Oil MPX2. The thesis does not include the population size and specific sampling techniques.

The research began with the design and creation of a prototype using an ESP8266, a TCS3200 sensor, and a waterflow meter. The sensor reads the color and flow of the oil, then the data is processed using a Rule-Based System to determine the oil's condition. The test results are displayed on a 16x2 LCD and sent to a Node.js server via a WiFi network to support real-time monitoring. Data collection was carried out through observation, literature review, and experiments (Ummah, 2019).

Results and Discussion

System Design Results

In this study, a system has been created and implemented to check the condition of automatic motorcycle oil based on the ESP8266 microcontroller (NodeMCU) using oil viscosity and color parameters. The YF-S401 waterflow meter sensor is used to measure the flow rate as a sign of the relative viscosity of the oil, while the TCS3200 color sensor is used to measure the color index value as a sign of oil color changes due to continuous use. Based on the calibration results, the viscosity value is classified into three categories, namely thick (1–3), normal (3–5), and thin (>5), while the color index value is classified into bright (93).



Figure 1. System Design Results

The resulting data from both sensors is then processed using a rule-based system to determine the oil's suitability category: very suitable, fairly suitable, or unsuitable. The results of the data processing are displayed directly on a 16x2 LCD screen and sent to a monitoring server via an internet network using ESP8266, so users can see the condition of the oil directly and in real-time. Thus, the system created can help people check whether the oil is still suitable for use more clearly and measurably than just looking casually.

Tool Testing Results and System Analysis

1. Hardware Design Results

In this research is a system to check the suitability of automatic motorcycle oil. This system consists of several main components, namely the ESP8266 microcontroller (NodeMCU), the YF-S401 waterflow meter sensor used to measure the relative viscosity of the oil, the TCS3200 color sensor that functions to recognize changes in oil color, a 16x2 LCD screen as a means of displaying results, and the NodeMCU expansion board that acts as a connector between components. All parts are designed and combined in a single prototype circuit using a single hose channel so that the oil flow remains stable, so that the sensor reading results become more consistent.

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Figure 2. Hardware Design Results

In hardware testing, each component works according to its designated function, where the waterflow meter sensor is able to measure the amount of oil flow, the TCS3200 sensor measures the oil color, and the results of these measurements are processed by the ESP8266 and then displayed directly on the LCD screen. Thus, the designed hardware successfully supports the system in carrying out the process of checking the suitability of automatic motorcycle oil automatically and in an integrated manner.

2. TCS3200 Sensor and WaterFlow Meter Test Results

Based on the evaluation results, the TCS3200 sensor can detect variations in oil color through its color index value, while the waterflow meter sensor can measure differences in oil flow, which serves as an indicator of viscosity levels. Information from both sensors is used as the basis for automatically categorizing oil suitability within the system.



Figure 3. Test Results If the Oil is Very Suitable



Figure 4. Test Results If the Oil is Suitable Enough

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Figure 5. Test Results If the Oil is Unfit

According to the test results, the TCS3200 sensor can detect oil color using the color index value, and the water flow meter sensor can measure the viscosity level through the flow value. The calibration results show that a flow of 1–3 is classified as thick, 3–5 is normal, and more than 5 is thin, and a color index of 93 indicates dark, so these two sensors can be used to automatically assess the suitability of oil in the system.

3. Oil Test Results on LCD

Based on the evaluation results that have been carried out, the 16x2 LCD can display information from the sensor clearly, including the value of the oil flow state and the oil suitability status classified as very suitable, quite suitable, or unsuitable. The display on the LCD makes it easy for users to see the inspection results directly and in real time after the oil viscosity and color reading process is complete, so that users can easily assess the oil condition without having to make manual observations.

Table 1. LCD test results

No	Condition	Oil Condition	LCD display
1	Normal	Very Worthy	
2	Normal	Quite Decent	
3	Abnormal	Not feasible	

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4. Unit Value Test Results and Results

The flow parameter is the average pulse count value generated by the Water Flow Meter sensor as a relative indicator of oil viscosity. The flow value is not expressed in viscosity units (cP), but rather as an index of the sensor reading results. Meanwhile, the color parameter is the color index value of the average TCS3200 sensor reading obtained from the Red, Green, and Blue channels without having a physical unit. Both parameters are then processed using the Rule Based System method to determine the oil's suitability status as Very Suitable, Suitable, or Not Suitable.

Table 2. Results of Testing Value Units and Results

No	Oil Testing	Flow	Color	Results (Output)
1	Motul GP Matic 10W-40	2	910	Very Worthy
2	Motul GP Matic 10W-40	2	940	Very Worthy
3	Motul GP Matic 10W-40	4	1782	Not feasible
4	Motul Expert LE 10W-40	2	980	Very Worthy
5	Motul Expert LE 10W-40	4	1250	Worthy
6	Shell Advance 10W-30	3	1320	Worthy
7	Shell Advance 10W-30	4	1480	Worthy
8	AHM MPX2 10W-30 Oil	5	1550	Worthy
9	AHM MPX2 10W-30 Oil	5	1680	Not feasible
10	AHM MPX2 10W-30 Oil	6	1820	Not feasible

5. Evaluation

Evaluation of test results was conducted to determine the extent to which the system works in determining whether automatic motorcycle oil is still suitable for use, based on color and viscosity parameters, using the Rule Based System method. Data obtained from the flow sensor and color sensor were processed using if-then rules to determine the condition of the oil suitable for use.

Criteria for determining flow value:

1-3=Thick
4-5 = Normal
>5=Runny

Color value determination criteria:

<1000=Very Worthy
1000-1599=Eligible
≥1600=Not Eligible

Based on the evaluation results, the system assigns a Very Suitable status if the color value is less than 1000 with thick or normal flow conditions. A Suitable status is generated if the color value is between 1000 and 1599, or a color value below 1000 with a liquid flow condition. Meanwhile, the Unsuitable status is canceled if the color value is 1600. The trial results show that the system can objectively assess whether the oil is suitable for use based on both parameters examined.

6. Website Monitoring View

The monitoring website in this study was used to display real-time oil measurement results. At the top, there's an "Oil Analyzer" heading indicating the system's identity, along with ON and OFF buttons to activate or deactivate the monitoring process. Furthermore, there's Device Status information indicating the device's connection status, indicating whether or not it's connected to the server.

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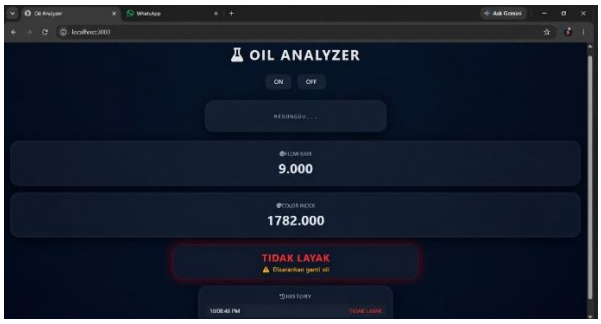


Figure 6. Website Monitoring Display

7. Coding Implementation Results

Based on the evaluation of the coding implementation results, the device on the ESP8266 microcontroller (NodeMCU) can function properly according to the system design. The system is able to collect information from the TCS3200 sensor to detect oil color and from the waterflow meter sensor to measure oil viscosity.

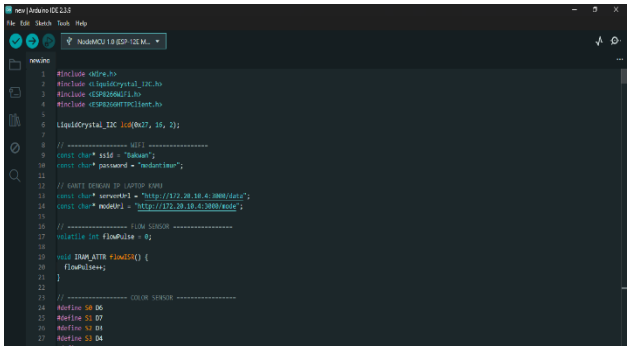


Figure 7. Coding in the Arduino IDE

The collected data is then processed using a Rule-Based System to evaluate the oil's suitability. The processed data is then displayed live on the LCD screen and sent to a server for monitoring, enabling the system to operate automatically, simplifying and clarifying oil condition assessments.

Table 3. Script Description

SCRIPT	EXPLANATION
#include <Wire.h> #include <LiquidCrystal_I2C.h> #include <ESP8266WiFi.h> #include <ESP8266HTTPClient.h>	used to call libraries required by the system. The Wire.h library is used for I2C communication between NodeMCU and external devices, LiquidCrystal_I2C.h is used to control the I2C LCD as a display medium, ESP8266WiFi.h is used to connect NodeMCU to a WiFi network, while ESP8266HTTPClient.h is used to perform HTTP communication so that measurement data can be sent to the server.
LiquidCrystal_I2C lcd(0x27, 16, 2);	used to create an I2C LCD object with address 0x27 and a display size of 16 columns × 2 rows. The LCD functions as an output medium used to display system information, measurement process status, and the final results of oil quality testing.
const char* ssid = "Tess"; const char* password = "abcdefgh"; const char* serverUrl = "http://192.168.227.109:3000/data";	Used to store network configurations, including the WiFi network name (SSID), WiFi password, and destination server address. This information is used by the NodeMCU to connect to the wireless network and send measurement data to the server using the HTTP POST method.

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volatile int flowPulse = 0;
void IRAM_ATTR flowISR() {
  flowPulse++;
}
	Used to manage data readings from the flow sensor. The flowPulse variable stores the number of pulses generated by the flow sensor, while the flowISR() function is an interrupt service routine that runs every time a pulse is generated by the flow sensor. Using interrupts allows the system to calculate fluid flow in real time with greater accuracy.

#define S0 D6 #define S1 D7 #define S2 D3 #define S3 D4 #define sensorOut D8	used to define the NodeMCU pins connected to the TCS3200 color sensor. Pins S0 and S1 are used to set the sensor output frequency, pins S2 and S3 are used to select the color filter to be read, while the sensorOut pin is used to receive the sensor output signal in the form of a frequency that represents the intensity of the detected color.
int redValue, greenValue, blueValue; int avgColor;	used to declare variables that store the color reading results from the TCS3200 sensor. The redValue, greenValue, and blueValue variables are used to store the values of the red, green, and blue color components, respectively, while the avgColor variable is used to store the average color value which will later be used as a parameter in the oil quality determination process.

bool isMeasuring = false;
unsigned long lastFlowTime = 0;
unsigned long lastFlowCheck = 0;
unsigned long lastIdleTCS = 0;
int flowRate = 0;
long totalFlow = 0;
int sampleCount = 0;
int avgFlowFinal = 0;
	is used to regulate the measurement and data processing process. The isMeasuring variable is used to indicate whether the measurement process is in progress or not. The lastFlowTime, lastFlowCheck, and lastIdleTCS variables are used to record time based on the millis() function to set the sensor reading interval. Meanwhile, the flowRate, totalFlow, sampleCount, and avgFlowFinal variables are used to calculate, store, and generate the average fluid flow value that will be used in the oil quality analysis process.

void sendData(
  String state,
  int flow,
  int color,
  Status string
) {
  if (WiFi.status() != WL_CONNECTED) {
  Serial.println("WiFi Disconnect");
  return;
  }
  WiFiClient client;
  HTTPClient http;
  http.begin(client, serverUrl);
  http.addHeader("Content-Type", "application/json");
  String json = "{";
  json += "\"state\":\"" + state + "\",";
  json += "\"flow\":" + String(flow) + ",";
  json += "\"color\":" + String(color) + ",";
  json += "\"status\":\"" + status + "\"";
	is used to send measurement results from the NodeMCU to the server using the HTTP POST method. Before the sending process is carried out, the system first checks the WiFi connection status to ensure the device is still connected to the network. Next, the system creates an HTTP Client object, specifies the destination server address, adds a JSON header, and then compiles the measurement results data consisting of process status, flow values, color values, and final classification results into JSON format. After the data is successfully sent to the server, the HTTP connection is closed to optimize device memory usage.

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```
  json += "}";
  Serial.println("SEND:");
  Serial.println(json);
  int httpCode = http.POST(json);
  Serial.print("HTTP Response: ");
  Serial.println(httpCode);
  http.end();
}
```

```
void readTCSAverage()
{
  long totalRed = 0;
  long totalGreen = 0;
  long totalBlue = 0;
  long totalAvg = 0;
  for (int i = 1; i <= 5; i++)
  {
    digitalWrite(S2, LOW);
    digitalWrite(S3, LOW);
    int r = pulseIn(sensorOut, LOW,
30000);
    digitalWrite(S2, HIGH);
    digitalWrite(S3, HIGH);
    int g = pulseIn(sensorOut, LOW,
30000);
    digitalWrite(S2, LOW);
    digitalWrite(S3, HIGH);
    int b = pulseIn(sensorOut, LOW,
30000);
    if (r == 0) r = 300;
    if (g == 0) g = 300;
    if (b == 0) b = 300;
    int avg = (r + g + b) / 3;
    totalRed += r;
    totalGreen += g;
    totalBlue += b;
    totalAvg += avg;
    delay(1000);
  }
  redValue = totalRed / 5;
  greenValue = totalGreen / 5;
  blueValue = totalBlue / 5;
  avgColor = totalAvg / 5;
}
```

The TCS3200 sensor is used to read color values from the TCS3200 sensor and calculate the average reading. The sensor will read the red, green, and blue color components alternately, taking five samples. Each reading is added together and the average value is calculated to obtain more stable color data. Taking multiple samples is done to reduce the influence of noise and fluctuations in sensor readings, resulting in more accurate and consistent oil color measurements.

```
void setup() {
  Serial.begin(115200);
  Wire.begin(D2, D1);
  lcd.begin(16, 2);
  lcd.backlight();
  pinMode(D5, INPUT);
  attachInterrupt(
    digitalPinToInterrupt(D5),
    flowISR,
    RISING
  );
```

Runs once when the NodeMCU is first powered on. This function initializes all hardware and software used in the system, such as serial communication, I2C LCD, flow sensor, TCS3200 color sensor, and WiFi connection. Furthermore, an interrupt on the flow sensor is activated so the system can automatically count pulses as the fluid flows. Once the initialization process is complete and the device is successfully connected to the WiFi network, the system will display a ready-to-use status on the LCD.

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pinMode(S0, OUTPUT);
pinMode(S1, OUTPUT);
pinMode(S2, OUTPUT);
pinMode(S3, OUTPUT);
pinMode(sensorOut, INPUT);
digitalWrite(S0, HIGH);
digitalWrite(S1, LOW);
WiFi.begin(ssid, password);
while (WiFi.status() !=
WL_CONNECTED) {
delay(500);
}
lcd.clear();
lcd.setCursor(0, 0);
lcd.print("READY...");
}	

if (millis() - lastFlowCheck >= 500)
{
flowRate = flowPulse;
flowPulse = 0;
lastFlowCheck = millis();
Serial.print("Realtime Flow: ");
Serial.println(flowRate);
}
	It is used to periodically calculate the liquid flow rate every 500 milliseconds. The number of pulses counted by the interrupt flow sensor is stored in the flowRate variable, and the pulse counter is then reset for the next measurement. The results are displayed on the Serial Monitor as real-time liquid flow rate information.

if (flowRate >= 2) {
if (!isMeasuring) {
isMeasuring = true;
totalFlow = 0;
sampleCount = 0;
lcd.clear();
lcd.setCursor(0, 0);
lcd.print("CHECK LIQUID");
lcd.setCursor(0, 1);
lcd.print("PLEASE WAIT");
sendData(
"processing",
0,
0,
"PROCESSING"
);
}
totalFlow += flowRate;
sampleCount++;
lastFlowTime = millis();
}
	Used to detect the start of the testing process when liquid flow passes through the flow sensor. When the flow value reaches a predetermined minimum limit, the system will enter measurement mode, clear previous measurement data, display inspection process information on the LCD, and send the processing status to the server. As long as the liquid continues to flow, flow data will continue to be collected for use in calculating the average liquid flow rate.

if (
isMeasuring &&
(millis() - lastFlowTime > 2000)
)
{
isMeasuring = false;
delay(3000);
readTCSAverage();
if (sampleCount > 0)
	Used to determine the end of the measurement process. The system will assume the fluid flow is complete if there is no change in the flow sensor pulse for more than two seconds. Afterward, the system waits for a few moments until the oil condition stabilizes, then takes a color reading using the TCS3200 sensor and calculates the average flow value based on all samples collected during the measurement process.

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avgFlowFinal = totalFlow / sampleCount;
else
avgFlowFinal = 0;
}	

if (avgFlowFinal > 5) {
flowStatus = "INTENSE";
}
else if (avgFlowFinal > 3) {
flowStatus = "NORMAL";
}
else {
flowStatus = "THICK";
}
	It is used to determine oil viscosity based on the average flow value obtained from the flow sensor. A high flow value indicates that the fluid flows more easily and is therefore categorized as thin, while a lower flow value indicates a higher viscosity. The results of this classification are used as one of the parameters in determining the overall oil quality.

if (avgColor >= 89 && avgColor <= 96) {
colorStatus = "VERY WORTHY";
}
else if (avgColor >= 96 && avgColor <= 99) {
colorStatus = "ELIGIBLE";
}
else {
colorStatus = "NOT VALID";
}
	used to determine the oil quality category based on the average color value obtained from the TCS3200 sensor. A predetermined color value range is used as the basis for classification so that the system can distinguish oil conditions that are still very suitable for use, suitable for use, or not suitable for use based on the detected color changes.

if (colorStatus == "NOT VALID")
{
finalStatus = "NOT VALID";
}
else if (
colorStatus == "VERY WORTHY" &&
(flowStatus == "NORMAL" || flowStatus == "THICK")
)
{
finalStatus = "VERY WORTHY";
}
else
{
finalStatus = "ELIGIBLE";
}
	is a decision-making rule used to determine oil quality based on a combination of color analysis results and viscosity levels. If the oil color falls within the "unsuitable" category, the final result is immediately declared unsuitable. If the oil color falls within the "very suitable" category and the viscosity level is normal or thick, the final result is declared very suitable. Beyond these conditions, the system will return a "suitable" final result.

lcd.clear();
lcd.setCursor(0, 0);
lcd.print("Condition:");
lcd.setCursor(0, 1);
lcd.print(finalStatus);
sendData(
"done",
avgFlowFinal,
avgColor,
finalStatus
);
	Used to display the final test results on the LCD and send them to the server. The displayed information includes the oil quality status obtained from the previous classification process. In addition to being displayed to the user, the measurement results are also sent to the server so they can be stored, monitored, or further analyzed through an application connected to the system.

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lcd.clear();
lcd.setCursor(0, 0);
lcd.print("Condition:");
lcd.setCursor(0, 1);
lcd.print(finalStatus);
	Used to display the final test results on the LCD. Before the information is displayed, the LCD screen is cleared to remove any data from the previous process. The system then displays the text "Condition:" on the first line and the oil quality classification results on the second line. This display serves as a direct source of information for the user regarding the condition of the oil analyzed by the system.

sendData("done", avgFlowFinal, avgColor, finalStatus);	Used to send final measurement results to the server after the entire analysis process is complete. The data sent includes process status, average flow rate, average color, and oil quality classification results. This information can be used by the server for data storage, oil condition monitoring, and further analysis.

delay(5000);
lcd.clear();
lcd.setCursor(0, 0);
lcd.print("READY...");
	This is used to allow the user time to read the test results displayed on the LCD. The system will maintain the results display for five seconds before returning to its initial state. After the timeout is over, the LCD screen clears and the system displays the "READY..." status, indicating that the device is ready for use again for the next test.

if (!isMeasuring)
{
if (millis() - lastIdleTCS >= 2000)
{
lastIdleTCS = millis();
digitalWrite(S2, LOW);
digitalWrite(S3, LOW);
redValue = pulseIn(sensorOut, LOW, 30000);
digitalWrite(S2, HIGH);
digitalWrite(S3, HIGH);
greenValue = pulseIn(sensorOut, LOW, 30000);
digitalWrite(S2, LOW);
digitalWrite(S3, HIGH);
blueValue = pulseIn(sensorOut, LOW, 30000);
if(redValue == 0) redValue = 300;
if(greenValue == 0) greenValue = 300;
if(blueValue == 0) blueValue = 300;
avgColor =
(redValue + greenValue + blueValue) / 3;
Serial.print("IDLE AVG : ");
Serial.println(avgColor);
}
}
	Used to periodically read the color sensor when the system is in standby mode or not taking measurements. Readings are taken every two seconds to ensure the sensor remains active and able to detect changes in environmental conditions around it. The resulting red, green, and blue color values are then averaged and displayed on the Serial Monitor as sensor monitoring information when idle.

lcd.setCursor(0, 0); lcd.print("READY... ");	Used to display standby status on the LCD when the system is not performing a measurement. The "READY..." display indicates that all system components are operating normally and the device is ready for subsequent oil quality testing.

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Conclusion

This research produces a system for checking the suitability of automatic motorcycle oil based on ESP8266 using color and relative viscosity parameters. The TCS3200 sensor is used to read oil color changes, while the waterflow meter is used to read the flow as an indicator of viscosity level. Data from both sensors is processed using a Rule Based System to produce categories of very suitable, suitable, and unsuitable. The test results show that the system can read parameters, process data based on predetermined rules, display results on a 16x2 LCD, and send data to the server for real-time monitoring. This system provides an alternative to checking oil conditions that is more measurable than assessments based on visual color observations.

The limitations of this research lie in the use of parameters that are still limited to color and relative viscosity, decision rules determined based on calibration results, and tests conducted on several types of automatic motorcycle oil so that the results cannot represent all types and conditions of oil. Future research is recommended to add parameters of temperature, turbidity level, and mileage of oil use and develop a decision-making method that is more adaptive to variations in oil conditions. Hardware also needs to be developed to be more compact, portable, and easy to use. Practically, the developed system can help users obtain information on oil conditions directly and support the determination of oil change times.

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