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# Flying Drone Controller by Hand Gesture Using Leap Motion

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## ABSTRACT

The Leap Motion is the mechanism to Flying Drone Controller by Hand Gesture Using Leap Motion. It has a sensor for hand gesture to fly a drone. This undertaking consists of a few hardware and software that are microcontroller Arduino, drone-like SYMA X5SC Explorer 2, Microsoft Visual Studio 2019, gesture sensor Leap motion and digital to analog MCP 4725. Leap Motion is taught by the manual motion and the Arduino instruction. Arduino receives the Leap Motion instructions, and the remote controller receives data from Arduino and sends signal to a drone immediately. Based on the hand gesture instruction, Drone flies into the air. There are three instructional conditions: throttle, pitch and roll. This system is designed to create a hand gesture instruction and to develop the program code of the features of the Leap Mo-tion using the Microsoft Visual Studio 2019. This technology has been explored and researched and many new things can be learned. Leap Motion was selected to operate a drone with a touchless condition for this task. There were three purposes in this task after investigations of the control system of hand gesture were made, particularly for drones. The planning is designed to ensure that the system fulfills its goals. It is suitable for farming, photography and military applications. Therefore, drone handling can be improved in future without shifting the key or pressing any control button.

**Key words :** Leap Motion; Hand Gesture, Drone

## 1. INTRODUCTION

This project is a hand gesture attempt to control a drone. It involves the development of an application using a Leap Motion [1] to recognize the user's hand gestures. This means that hand gestures must be recognized first. It can later be extended to more difficult gestures. The application then transforms the recognized hand gestures into signals to control the drone [2, 10-19].

Drones are commonly used in these days for a variety of purposes, including flying videography, photography, identification, and so much more. In many cases, a talented pilot has the necessary condition for carrying out these tasks with the auto which ends up over the top. A simple motion controller can make guidance much less difficult. Motion makes a reference particularly to every hand or face recognition, to any significant movement or gesture. The Leap Motion is used for implementing this project to detect gestures and receive instructions from a hand gesture. Ultimately, the motion of the drone is controlled by our hand [3]. Below is the picture of Leap Motion Controller in Figure 1.

**Figure 1:** Leap Motion Controller

### 1.1. Problem Statement

Today's drones are designed to fulfil a large range of critical tasks. Engineering systems involve technologies from a broad variety of disciplines, including aerodynamics, structures, propulsion, avionics and sensors. They are complex and include highly complex systems. Advanced interfaces, like switches, buttons, knobs, throttle, joystick and rudder pedals are necessary for operating these complex systems. Today's complex drone system operators are highly skilled and trained to learn how to drive modern drone systems. In order to reduce the skills and training required to operate today's drones, it would be worth exploring alternate ways to simplify the user interface.

### 1.2. Objective

1. To identify all possible gesture that can be detected by the gesture capturing device, then assign them to drone's function.

2. To create an interface between the Leap Motion and the computer to start the control transmission process to the drone.
3. To develop a system where the remote controller for controller RF/IR drone is to be taken over or replaced by modifying its internal circuitry or synthesizing communication protocols.
4. To evaluate a modified controlling system better than the classic controlling system and able to react with the hand gesture as an input for the drone.

## 2. SYSTEM FLOWCHART

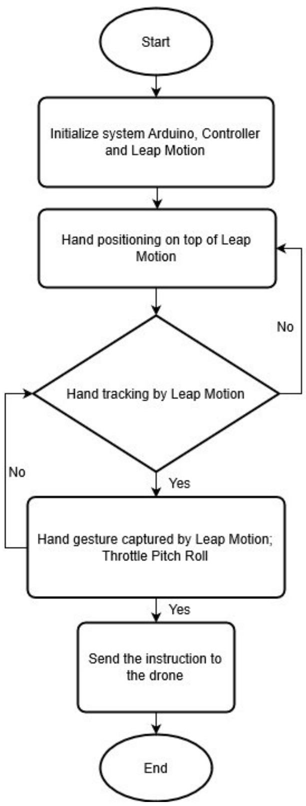


**Figure 2:** System flowchart

## 3. SYSTEM ARCHITECTURE

This section contains the System Architecture. This diagram serves as a guideline for the completion of this project according to the specified period. In Figure 3 it is also an important step towards the architecture of the system layout. In this task, the Arduino microcontroller consists of several components, the remote control of the drone to relay signal data to the drone. The system between Leap Motion and the drone will be adjusted to the remote control. As a quadcopter, Drone SYMA X5SC will be used. The Microsoft Visual Studio 2019 platform is providing a hand gesture instruction to Arduino, and the MCP4725 is supported by a digital-to-analog converter to transmit hand gesture instructions to the remote drone controller. The remote control modified is transmitting signal data to the drone. The drone will receive information and will travel as a gesture instruction.

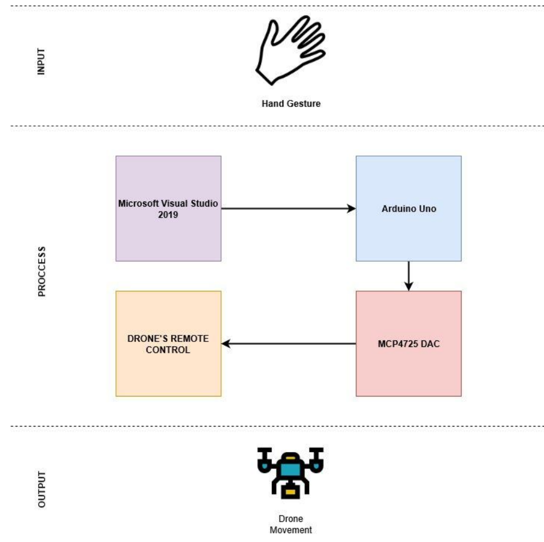


**Figure 3:** System architecture

## 4. SYSTEM OVERVIEW

This section addressed the outcome of the project for analyses and experiments to evaluate the Flying Drone Control by Hand Gesture Using Leap Motion features and results. Figure 4.1 shows the complete model stem of the project.

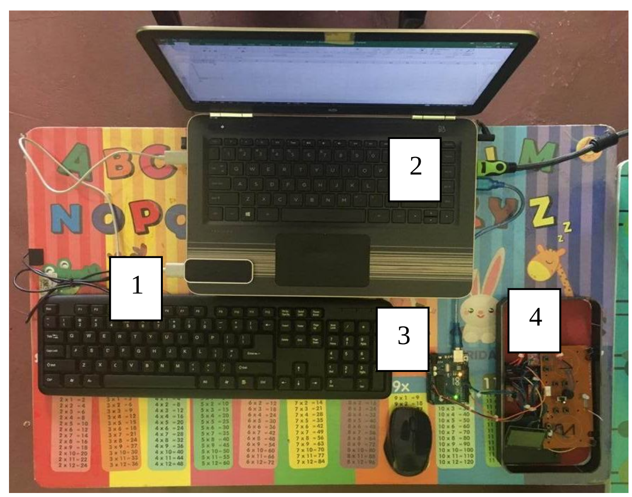


**Table 1:** Description on system overview

| No | Description |
|---|---|
| 1 | Leap Motion Controller as a sensor to detect the hand gesture as an input. |
| 2 | Computer on operating the software system and showing the GUI using Microsoft Visual Studio 2019 that acted as a translator for hand gesture from Leap Motion. |
| 3 | Arduino Uno board is the microcontroller that receives and transmits instructions on the hand gesture to the modified DAC drone remote control. |
| 4 | Modified drone's remote-control circuit. |

## 5. SYSTEM ANALYSIS

A drone can control four motors, increasing the angular speed of the propeller, which affects the thrust and moments further. According to classical mechanical theory, the rigid body can be converted into a force and a corresponding moment, while the moment can be directly translated into the centre axis. The thrust and moments around its core are therefore controlled. The attitude and position of a drone are regulated by changing thrust and moments. As in Figure 4, all propellers rotate at the same angular speed at a hover position, with Propeller #1 and Propeller #4 and spinning counter clockwise. In mean time Propeller #2 and Propeller #3 clockwise.

When drone is hovering, the sum of the four thrusts generated compensates the quadcopter's weight. Four propeller thrusts have the same thrust and four propeller moments are zero. To begin, need to synchronize the drone and keep it in a horizontal position before flying the drone. Move the hand closer to the Leap Motion and move the hand back away from the Leap Motion for the least throttle position. The changed remote control should make one clear sound, which will indicate that the drone has entered the pre-flight phase


**Figure 4:** A drone while hovering flight

### 5.1. Upward-and-Downward Movement

The Upwards-and-Downward movement of the drone upwards and downwards. The positive throttle will increase the flying impact of the drone and the negative throttle will lower the drone.

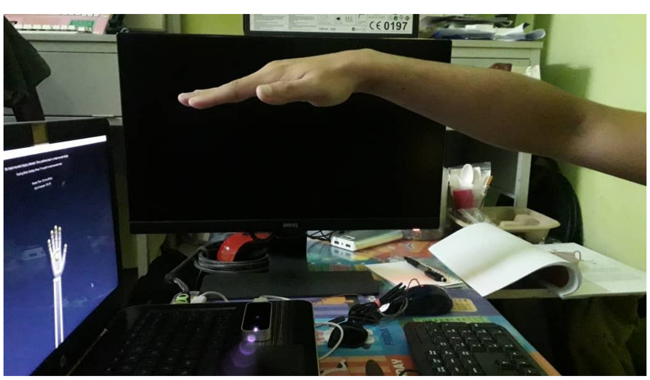

**Figure 5:** Hand gesture for upward drone's movement

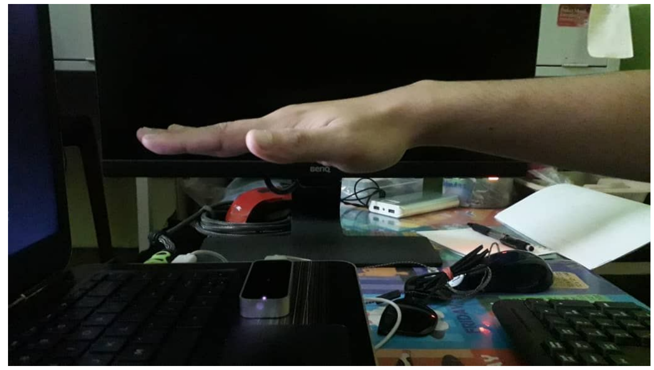

**Figure 6:** Hand gesture for downward drone's movement

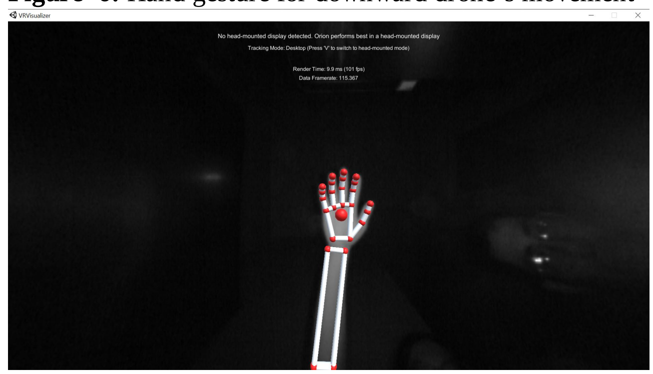


**Figure 6:** Leap Motion Visualizer interpreted the hand gesture

As shown in Figure 5 and Figure 6, Leap Motion controller detect the movement of operator's hand upward and downward and can be show via Leap Motion Visualizer, shown in Figure 7. The angular speeds of the propeller are increased by the same amounts. This will increase the thrust of the four propellers, but the moments still amount to 0. If the drone is placed on a flat ground, then the thrust moves up once it is larger than the drone's weight. Otherwise the drone moves down when the angular velocity of the propeller diminishes by the same amount.

### 5.2. Forward-and-Backward Movement

The Forward-and-Backward movement is when the drone's forward and reverse tilt. The positive tilt makes the drone tilt and pitch going forward, while the negative tilt will make the drone tilt backward and reverse.

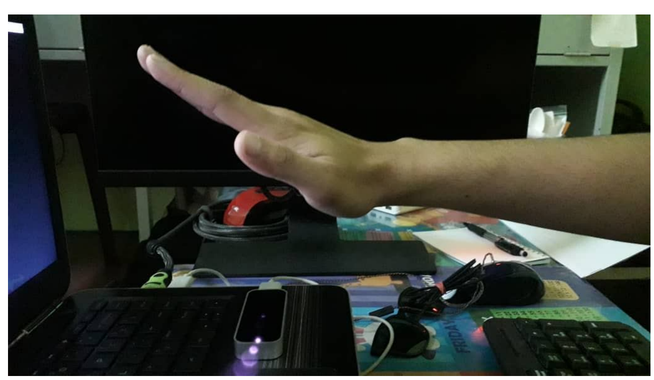

**Figure 7:** Hand gesture for forward drone's movement

**Figure 8:** Hand gesture for backward drone's movement

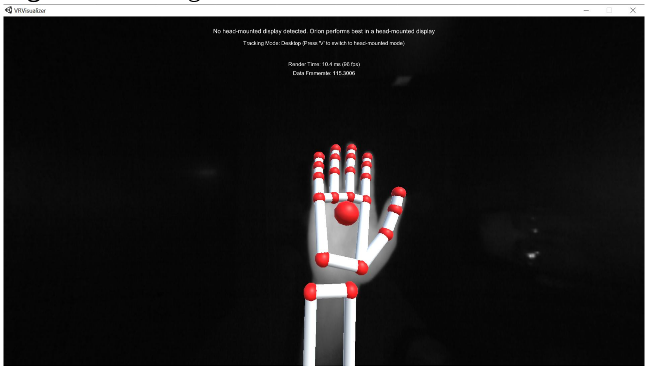


**Figure 9:** Leap Motion Visualizer interpreted the hand gesture

As shown in Figure 7 and Figure 8, Leap Motion controller detect the movement of operator's hand forward and backward and can be show via Leap Motion Visualizer, shown in Figure 9. The angular speed of the propellers #3 and #4 is decreased by the same amounts while the angular speed of propellers #1 and #2 is increased by the same amount. This leads to a moment that pitches the drone forward. The thrust then has a forward component. Nevertheless, the vertical portion of the thrust, which does not equal the weight of the drone, has decreased at this stage. Therefore, the four angular speeds of the propeller should be increased by the same amount to account for the weight. The reverse motion can also be achieved.

### 5.3. Leftward-and-Rightward Movement

The Leftward-and-Rightward movement is the drone tilt side to side. Positive rolls make the drone tilt right, and negative rolls tilt the drone left.

**Figure 10:** Hand gesture for leftward drone's movement

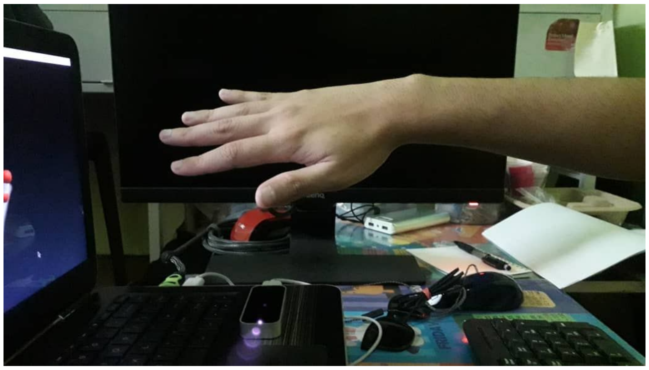

**Figure 11:** Hand gesture for rightward drone's movement

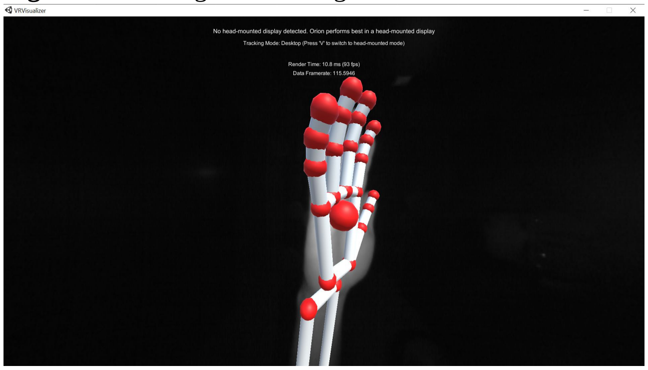


**Figure 12:** Leap Motion Visualizer interpreted the hand gesture

As shown in Figure 10 and Figure 11, Leap Motion controller detect the movement of operator's hand leftward and rightward and can be show via Leap Motion Visualizer, shown in Figure 12. The angular velocities of propeller #2 and #4 are decreased similarly while propeller #1 and #3 angular velocity is increased equivalently. This leads to a moment when the drone rolls right. The thrust then has a right component. The vertical component of the thrust is decreased, however, which is not equal to the drone weight. Therefore, the four propeller angular velocities should be further increased by the same amount to account for the weight, based on the preceding adjustment of the four propellers. The left-wing movement can also be done in the same way.

### 5.4. Program States

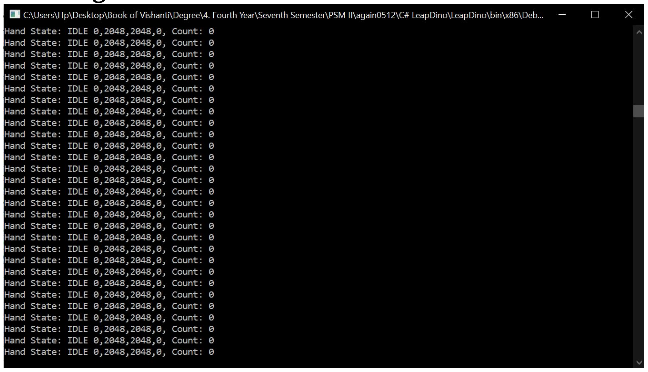


**Figure 13:** Console App displayed IDLE State

The Console App from Figure 13 is when the drone in the IDLE state that the baud rate will remain 0. This is because the Leap Motion sensor are not detected any hand gesture from the operator as mention that this will made the drone not flying or moving even when it is ON. Even the propeller of the drone is not rotating in this state. The value from COUNT indicate the finger detected by the sensor.

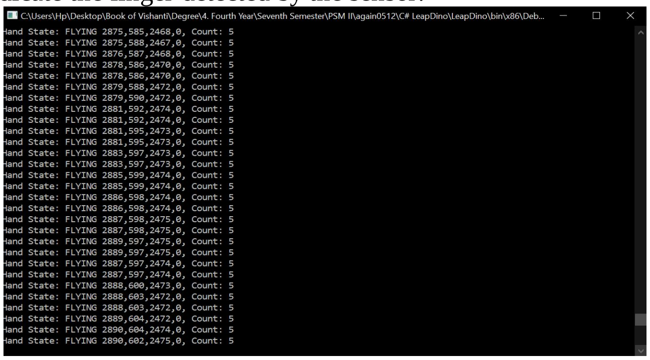


**Figure 14:** Console App displayed FLYING State

FLYING state will start show when the connection between drone and the remote-control box are made. They will be a clear sound when the connection between this 2 are made. The baud rate started from 2048 is the range value that which these 2 instruments will connected. The FLYING state is consisting of two condition, the first one will be pre-flight state and the second one is when the drone itself are flying. The COUNT indicates 5 which means the Leap Motion able to be detected all of the fingers as shown in Figure 14.

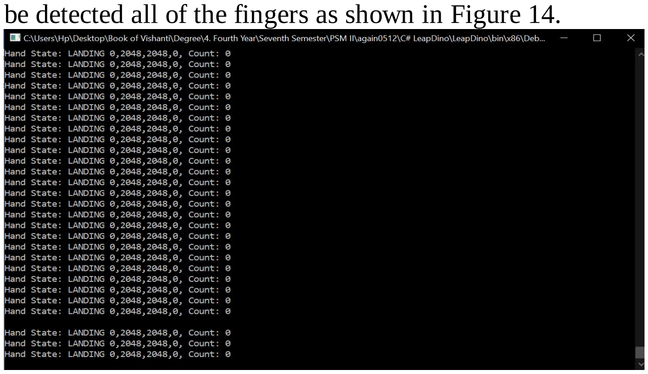


**Figure 15:** Console App displayed LANDING State

The other state that been declared in the program is the LANDING state, refer from Figure 4.5. The LANDING state occur right after the FLYING state baud rate turn 0 from the higher value and right before changed into IDLE state.

### 5.6. Graph Analysis

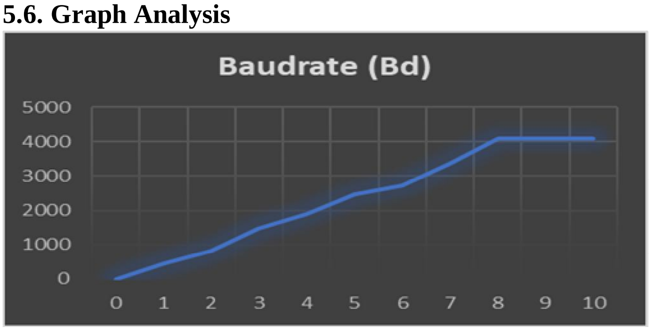


**Figure 16:** Graph indicate the drone connection

Start from neutral baud rate, 2048 until the highest baud rate which is 4095 are the exact range of baud rate when will the connection is happening. The value baud rate relate to the time are varied as the movement are not constant. Near 8 second, usually the line graph will stay constant at bad rate value 4095 as shown in Figure 16. This is because that the highest baud rate declared in the program.

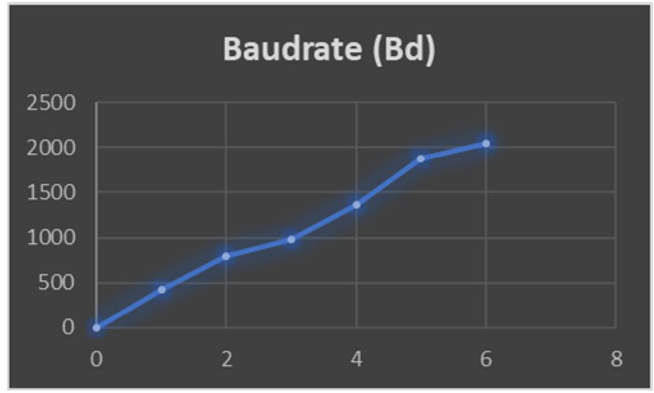


**Figure 17:** Graph indicate the drone static positioning

Drone Static Positioning condition when the drone is in pre-flight state and ready to fly depends on the hand gesture detected from the Leap Motion. From Figure 17, at 0 seconds the drone propellers will start rotating and at this condition the drone will remain grounded even the propellers are moving. This condition happens only for almost 6 second until the drone are ready `to fly, only begin when the baud rate reach neutral baud rate 2048. But this depend on the movement of the operator as the baud rate will change drastically. The graph from Figure 17 show that it is climbing slowly within 6 seconds.

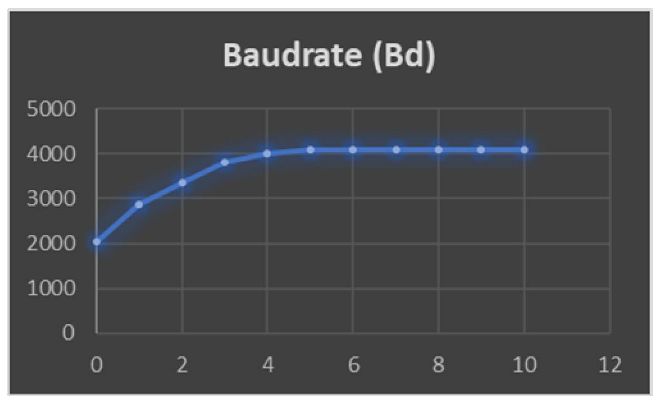


**Figure 18:** Graph indicate the drone dynamic positioning

The baud rate will begin at 2048 for this condition as the drone will start hovering on air. The limitation baud rate will be 4095 as declared in the program but this will not ensure that the drone will stop at certain height just because the baud rate limits. As the other condition, the drone dynamic position also depends on the movement on the hand gesture detected from the Leap Motion.

## 6. CONCLUSION

This task has been successfully planned and tried. After inquiries about the system for the hand gesture control particularly for the drone, three objectives were made meaningful in this mission. When the sight of the target is clear, the advancement of the project process occurs. An analysis of the paper was also undertaken so that the newest development that were important to the business could be represented and introduced. The reach of containment is a guide in some articles. In response to the social event data, the methodology process was conducted. Centres for equipment use and programming execution are provided during this process.

Proper use of equipment is a decent result in the use and use of value. Meanwhile, the configuration of the programming was designed to ensure that the equipment met its objectives. The procedure followed was an attempt to collect information. The tests were conducted stage by stage. The analyses and measurements are standardized and broken down. Regarding the performance, it indicates that the undertaking fulfils the entire target requirement.

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