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The Development of Real-Time Facemask

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The Development of Real-Time Facemask

Stephan Chae ^α, Jungwhan Cho ^σ & Hwa Sung Chae ^ρ

I. INTRODUCTION

The maxilla articulates with nine other bones: the frontal cranial and the ethmoid, as well as the “nasal, zygomatic, lacrimal, inferior nasal concha, palatine, vomer, and the adjacent fused maxilla.” It is connected to other bones above through sutures. (Figure 1).

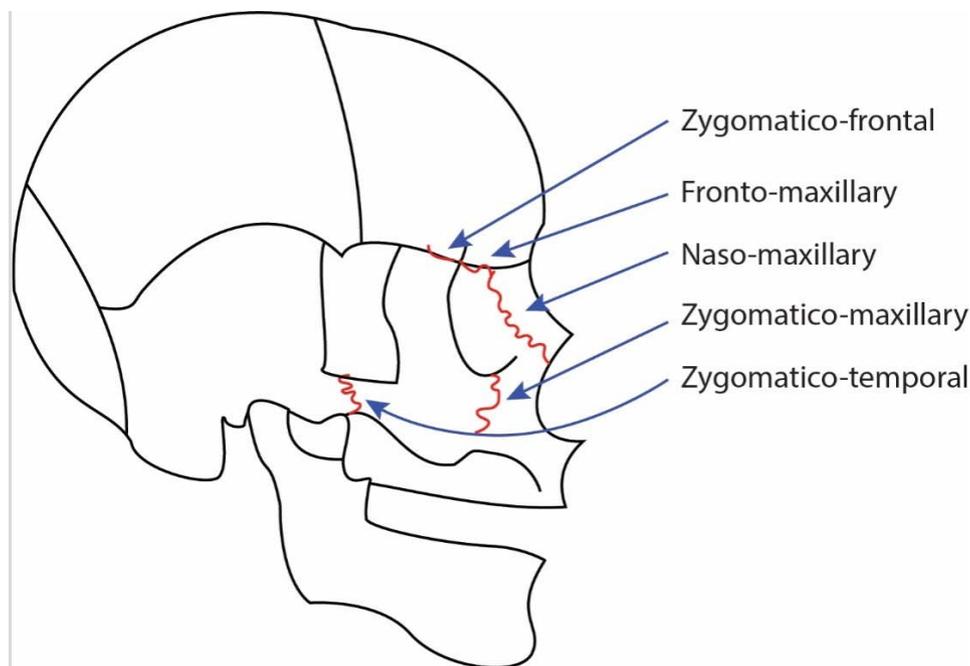


Figure 1: A depiction of circummaxillary sutures

In growing children, the maxilla departs from circummaxillary sutures when face mask treatment is applied(1). Face masks, also called reverse-pull headgear, have been used throughout much of history to move the maxilla both forwards and downwards in patients with midfacial deficiencies (2). Figure 2 depicts the clinical application of a face mask.

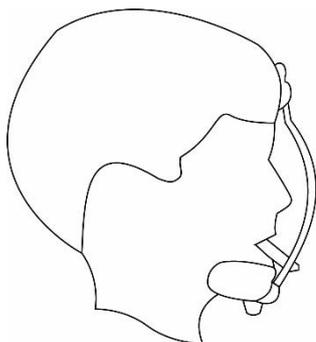


Figure 2: Clinical application of a face mask

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The best treatment timing for growing patients is still controversial, and the correlation between cooperation and age is one of the most confounding variables. (3-5)

The recommended wearing time of a face mask is usually longer than 14 hours in a day (6) (7), but this is entirely dependent on the cooperation of the patient. Studies report that received compliance is insufficient (8) (9). A previous study suggested measuring wear time using TheraMon chip technology, which used sensors that collected time and temperature data. It was placed on the forehead of the patient. (10)

However, to our knowledge, no attempt has been made to measure the force applied against the full reverse headgear in real-time. Since the suggested force for face masks lies around 300 to 400 grams, keeping this pressure consistent, especially during sleep, is a challenge. To overcome the complications in this process, we used IoT technology and transferred the collected data onto their phone in real-time to use as an asset. This data could be used to create an entirely



new system to analyze the data procured by face masks to personalize assistance for each patient.

II. MATERIALS AND METHOD

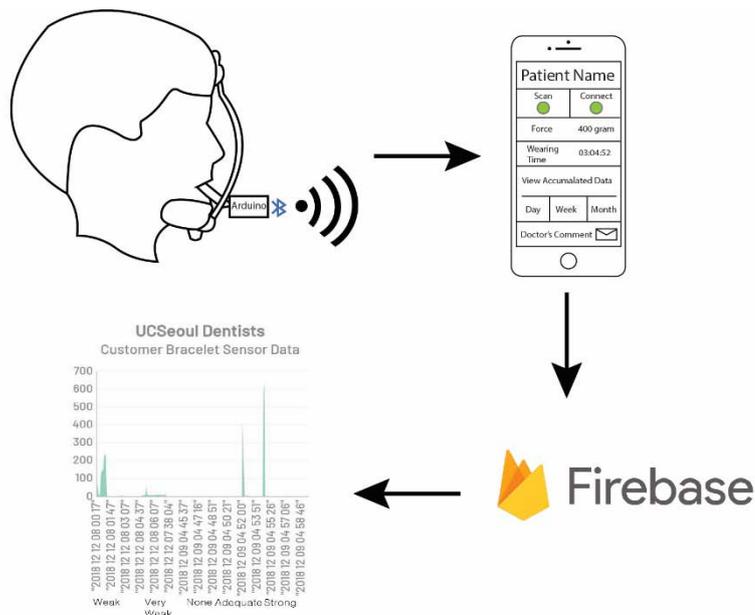


Figure 3: Demonstrates the role of each component and the feature of combination.

1. Load Cell Weight Sensor (AD Module ESU)

This sensor used rubber bands to detect the weight applied to the face mask.

Arduino Force Sensor Circuit

This force sensor converted the code from the sensor into units (grams).

MIT App Inventor

The face mask patient would run an app to connect their phone to this Bluetooth circuit, which was coded (Figure 4) and designed using MIT App Inventor. When a subject presses a 'scan' button, it will send data to the phone. (Figure 5)

Arduino Bluetooth Circuit

This connects the Arduino force sensor to the Bluetooth network, connecting the sensors and the patient's phone. This required coding to detect when the data should be sent, i.e., when the LED was turned on, signifying that the Bluetooth signal was functioning.

Google Firebase

This database sent data from Arduino Bluetooth so that it could be accessed by people other than the patient, making the system functional. (Figure 6) There was also a private cloud generation process necessary to prepare it. Once data is transported from the phone to Google Firebase, the database offers it to both the patient and the orthodontist.

```

when led_On .Click
do
  if BluetoothClient1 IsConnected
  then
    if led_on Text = LED ON
    then
      BluetoothClient1
      1
      led_on Text LED OFF
    else if led_on Text = LED OFF
    then
      BluetoothClient1
      0
      led_on Text LED ON
  end if
end if

when ListPicker1 .BeforePicking
do
  set ListPicker1 Elements to BluetoothClient1 AddressesAndNames

when ListPicker1 .AfterPicking
do
  if call BluetoothClient1 .Connect
  address ListPicker1 Selection
  then
    set Label1 Text to Connected

when disconnect .Click
do
  call BluetoothClient1 .Disconnect
  set Label1 Text to Disconnected

```

Figure 4: Code used to transfer data from the Arduino to the phone via Bluetooth

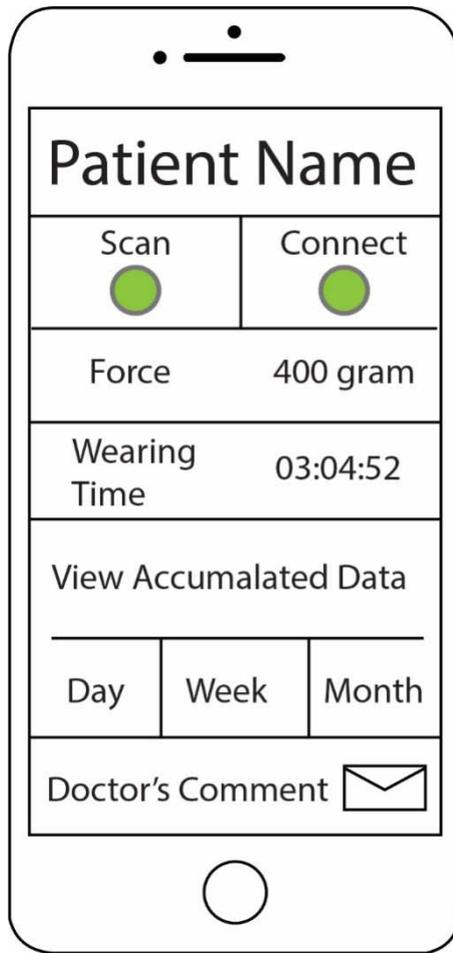


Figure 5: Composition of the app. Displays the current force and the wearing time of the individual

```

when Clock1.Timer
do
  if BluetoothClient1.IsConnected
  then
    if call BluetoothClient1.BytesAvailableToReceive > 0
    then
      set global db_user_id to nameTextBox.Text
      set global bt_value to call BluetoothClient1.ReceiveText
      numberOfBytes call BluetoothClient1.BytesAvailableToReceive
      set rxDataText.Text to get global data_index
      set global data_index to get global data_index + 1
      call FirebaseDatabase1.StoreValue
      tag join get global data_index /label
      valueToStore call Clock1.FormatDateTime
      Instant call Clock1.Now
      pattern yyyy/MM dd hh mm ss
      call FirebaseDatabase1.StoreValue
      tag join get global data_index /value
      valueToStore get global bt_value
    end if
  end then
end if
end do
    
```

```

when btListPickerBtn .BeforePicking
do set btListPickerBtn Elements BluetoothClient1 AddressesAndNames

when btListPickerBtn .AfterPicking
do if call BluetoothClient1 .Connect address btListPickerBtn Selection
then set bt_status Text to Connected

when disconnectBtn .Click
do set bt_status Text to Disconnected

when getSensorDataBtn .Click
do call BluetoothClient1 .SendText text 2

initialize global bt_value to 
initialize global db_user_id to 사용자ID
initialize global data_index to 0
    
```

Figure 6: Code used to send data from Arduino to Google Firebase

III. RESULTS

Utilizing face masks and IoT technology, we were able to detect whether and how much weight (0 to 1000 grams) was being applied to a face mask in real-time with an interval of thirty seconds. (Figure 7).

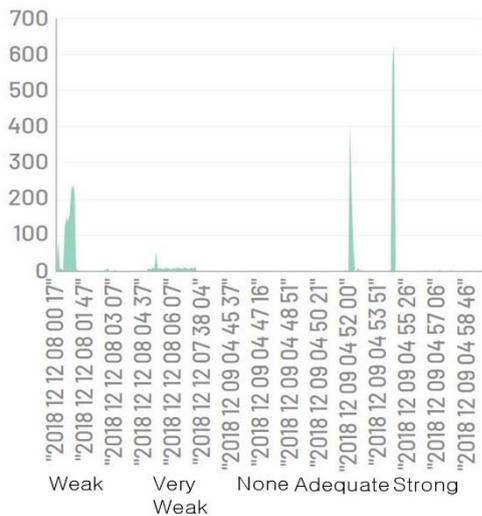


Figure 7: Chart of real-time measured pressure

IV. DISCUSSION

Orthodontists always strive to apply the optimal force to their patient's orthodontic devices. However, due to the amount of patient cooperation necessary to conduct their practice successfully, keeping track of

how much force is being applied at home and outside of the clinic seems impossible.

The advent of IoT technology could potentially solve his problems.

It opens comprehensive treatment care for both doctors and patients (Figure 3). When the patients wear the facemask attached to the sensor, Bluetooth will transfer the amount of force to their cell phones. The data is real-time based, and the patient can identify the force level, which is also shown graphically in the background (Figure 4). Further warning messages or beeps will be incorporated when the patients use weak or loosened elastics or insufficient wearing time is noted. Our results were able to detect and digitalize how much weight was being applied, as well as the patient's cooperation. Such data collected will enable far more concise feedback for patients in the future. Besides, the accumulated results will be able to reveal efficient wearing time and force for individual patients, rather than just longer than 12 hours a day. Therefore, doctors can instruct individualized optimum force and wearing time based on scientific evidence with confidence.

V. CONCLUSION

We suggested an IoT based tractable system for a facemask. This workflow can be widely applicable to any removable appliances in the future. Collected data will provide a comprehensive understanding of optimal force and timing for the treatment.

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