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The Development of Real Time Facemask

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ABSTRACT

Introduction: In patients with maxillary deficiency, facemask treatment for growing patients has been used throughout much of history to move the maxilla both forwards and downwards. The recommended wearing time of a face mask is usually longer than 14 h in a day.

Objective: Patient's cooperation and 300-400 gm. consistent force are essential for the treatment outcome. However, no attempt has been made to measure the force applied against the reverse full headgear in real time. The objective of this study is how to analyze patients wearing time and the amount of force in real time, utilizing the internet of things (IOT).

Materials & Methods: "Real time facemask" composes of Load Cell Weight Sensor (AD Module ESU) connected to the facemask, Arduino Force Sensor Circuit, MIT App Inventor, Google Firebase. The doctor and the patients can assess the cloud-based wearing time and analytics.

Results: Utilizing face masks and IOT technology, we were able to detect whether and how much weight (0 to 1000 g) was being applied to a face mask in real time with thirty seconds interval.

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.

Keywords: Maxillary deficiency, Facemask, Real time, The internet of things, MIT App Inventor

Abbreviations: IOT: Internet of things; MIT: Massachusetts Institute of Technology; App: Application

INTRODUCTION

The maxilla articulates with nine other bones, these being the frontal cranial and the ethnocide, 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)**.

In growing children, the maxilla departs from circummaxillary sutures when facemask treatment is applied [1]. Facemasks, 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]. The clinical application of a facemask is depicted in **Figure 2.**

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 facemask is usually longer than 14 h in a day [6,7], but this is completely dependent on the cooperation of the patient. It has been reported that received compliance is insufficient [8,9]. A previous study suggested to measure the wearing time using TheraMon chip technology used sensors that collected the data of wearing time and temperature. 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 reverse full headgear in real time. Since the suggested force for facemasks lies

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around 300 to 400 g, to keep the force consistent, especially during sleep, seems critical for the outcome, yet difficult to do so. To overcome the complications in this process, we used Internet of Things (IOT) technology and transferred the collected data onto their own phone in real time to be used as an asset. This data could be used to create an entirely new system to analzye the data procured by facemasks to personalize assistance for each patient.

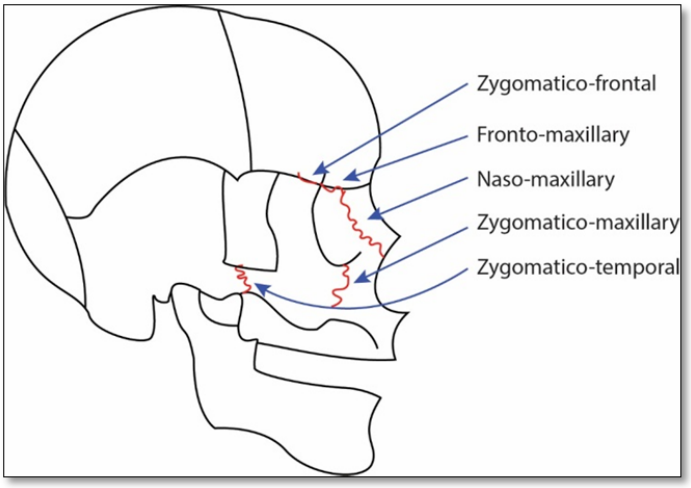

Figure 1. Depiction of circummaxillary sutures.

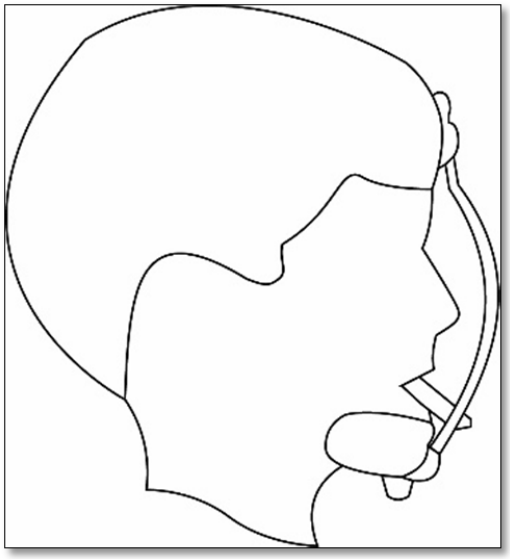

Figure 2. Clinical application of a facemask.

MATERIALS & METHODS

Load cell weight sensor (Arduino Module)

This sensor used rubber bands to detect the weight applied to the facemask.

Arduino force sensor circuit

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

MIT app inventor

The facemask patient would run an app to connect their phone to this Bluetooth circuit, which was coded **(Figure 3)** and designed using Massachusetts Institute of Technology (MIT) Application (App) Inventor. When a 'scan' button was pressed, data would be sent to the phone **(Figure 4)**.

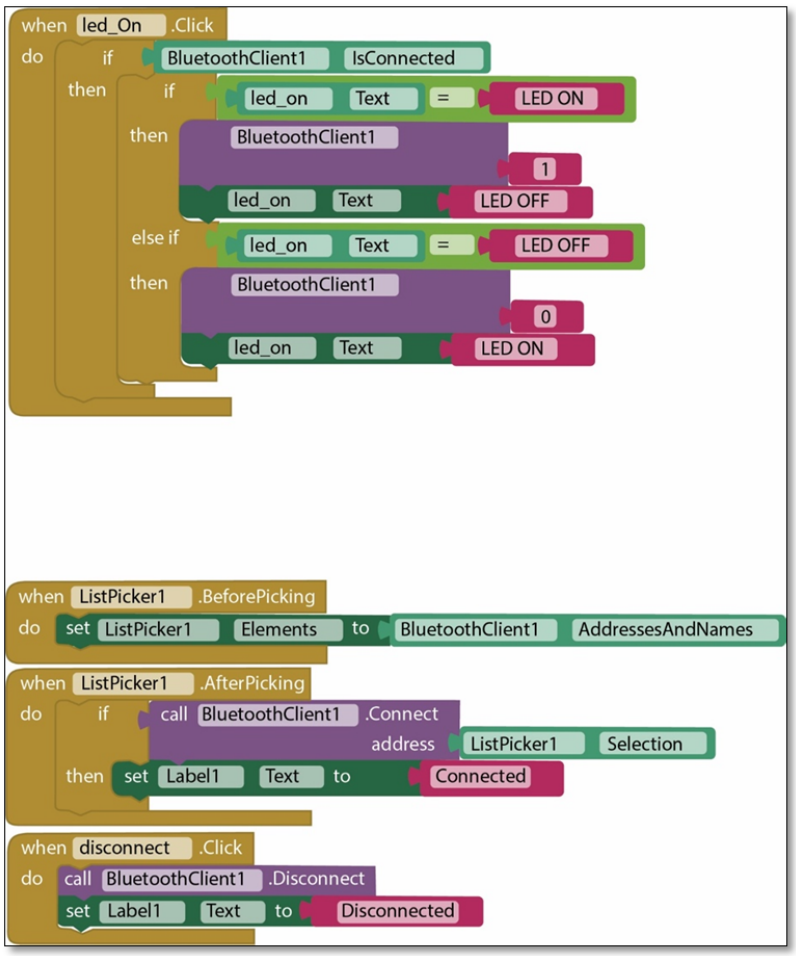

Figure 3. Code used to transfer data from the Arduino to the phone via bluetooth.

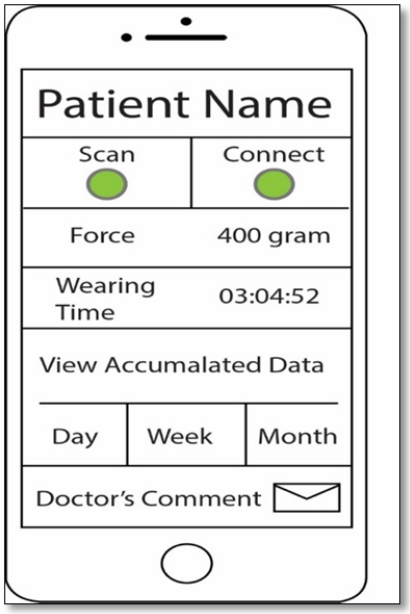

Figure 4. Composition of the app displays the current force and wearing time of individual.

Arduino bluetooth circuit

This connected the Arduino force sensor to the bluetooth network, being a bridge between 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 as well, making the system functionable required coding as well **(Figure 5)**.

There was also a private cloud generation process necessary to prepare it.

Once the data was transferred from the phone and onto Google Firebase, it was then transferred again to be available both to the patient and the orthodontist.

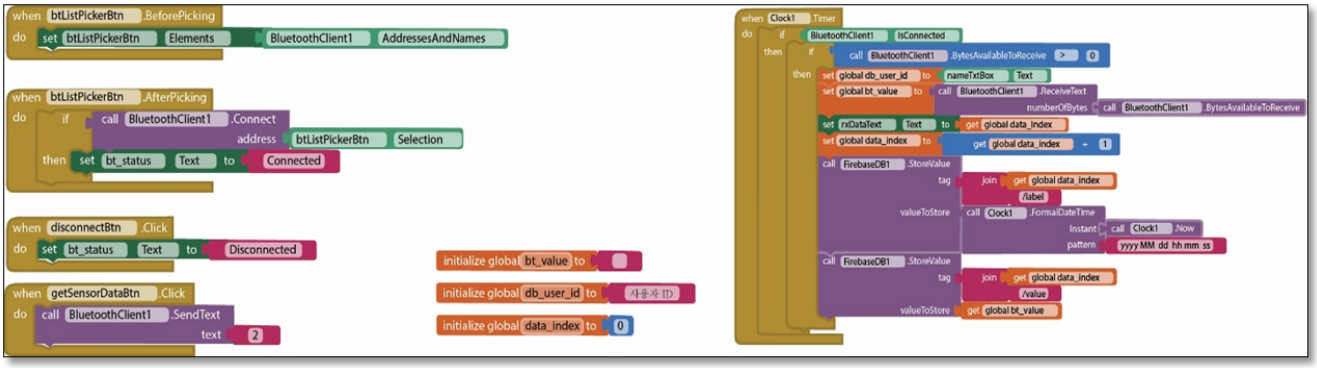

Figure 5. Code used to transfer and store data in Google Firebase.

RESULTS

Utilizing facemasks and IOT technology, we were able to detect whether and how much weight (0 to 1000 g) was being applied to a facemask in real time with an interval of thirty seconds **(Figure 6)**.

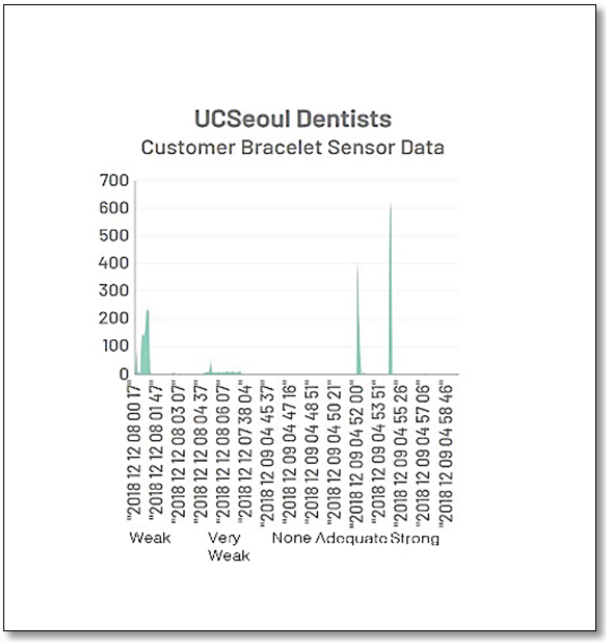

Figure 6. Chart displaying recording of strength levels.

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 successfully conduct their practice, 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 a comprehensive treatment care for both doctors and patients **(Figure 7)**. 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 3)**. 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 cooperation of the patient. 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.

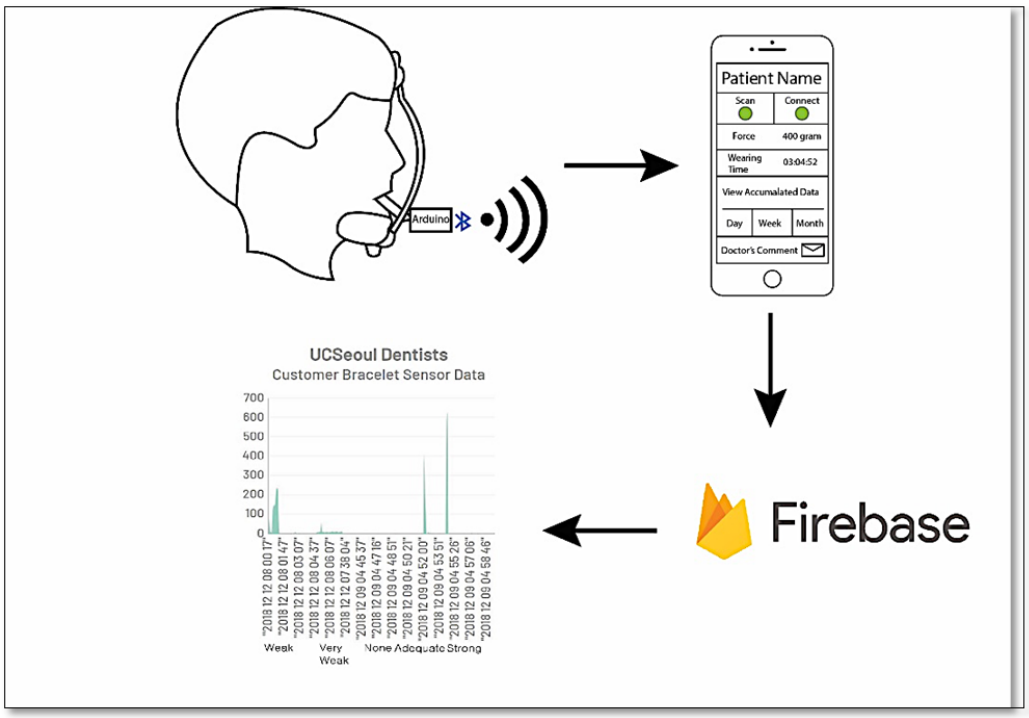

Figure 7. Role of each components and the feature of combination.

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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