Team Name	Team 1.0
University	University of Moratuwa
Product Name	Carbon Emission Monitoring and Controlling System Using Terahertz Communication.
Category	Undergraduate

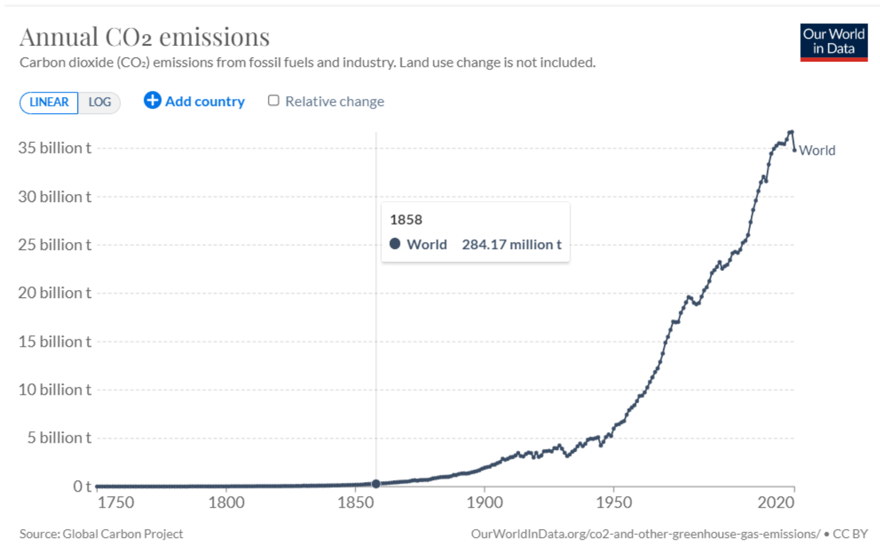
Problem Definition, Analysis, and the Solution

Now a days the green house effect has become a major talkative concern. Mainly, the emissions of CO_2 and the toxic gases create a major impact on this drastic increase of greenhouse emission.

As we can see in the graph around 31.5Gts of CO_2 has been released to the atmosphere in 2020.

Sri Lanka is not also an exception. In 2021 we have emitted 23.78Kts of CO_2.

So, these emissions lead us to an undesirable result. The one of the main reasons for this situation we don't have a proper monitoring system to control the emissions.



Normally in outdoor areas CO_2 concentration won't change considerably without any significant reason.

On the other hand, in indoors that is a different scenario. As CO_2 concentration often tends to have a substantial change. In that case, there should be an implementation to detect these prominent changes in CO_2 concentration in both indoor and outdoor areas.

Therefore, we came up with an innovative idea of monitoring CO_2 emissions using Terahertz range frequencies, to cover a large area as well as implement a way of control the emissions.

Product overview and Uniqueness of the Product

Terahertz communication is an emerging study in the present era. Rather than the present 5G technologies, terahertz frequencies offer some advantages like extending an even larger bandwidth to utilize it effectively. And also, as we said earlier, we are using terahertz frequencies because we just utilize the IR absorption property of CO_2 and other toxic gases. Whereas a significant range of IR rays falls within the terahertz frequency region.

If we seek the current available CO_2 sensors in the market most of the sensors are used for point-wise detection or for a small area. And also, these products measure the concentration of CO_2 by measuring the charge induced by CO_2 when it gets reacted with a polymer surface and therefore can only use with some restrictions.

But in our case, as we use IR waves, we can extend our workspace to a considerable amount of area when compared with others. And also, we think of refining our product furthermore to notify when there is a sudden detection of CO_2 change in a specific area and alert the relevant organizations to control their CO_2 and toxic gas emissions.

Business Model and Marketing Plan

Basically, we are planning to launch our product to the market under two categories.

1. Indoor monitoring system
2. Outdoor large coverage area monitoring system

From these categories as an initiation, we introduce our indoor monitoring system for about 10 industrial factories because those are the places that monitor their indoor CO_2 and toxic gases concentration continuously. From those factories, we will get feedback about our product, and we will correct and modify our product if it has bugs or errors.

After that again we introduce our completed product to about 100 factories and we give some trial time to them and use and experience our product. After the trial time, we assume more than 50 factories among those will buy our product and after that, we directly launch our indoor monitoring system in the local market.

Our goal is to sell more than 1000 items within the first year and after we complete 1000 items, we will begin to mass produce our product for the local market as well as foreign market.

That's the plan for our indoor monitoring system.

After we success with our indoor monitoring system, we introduce our Outdoor large coverage area monitoring system. It takes some time because we need to design and test high-sensitivity receivers, make high accurate algorithms, design high powerful antennas, and such things.

Another thing is, as the Terahertz Communication is currently in the testing phase, we have also tested this considerable time.
After done our testing part as we have done earlier we will establish our system in an industrial city and we get all data to prove the correctness and accuracy of our system.

Often the customer of this product is not an ordinary businessman or a small factory.
This is most useful for government organizations established to protect the environment, state governments, and organizations in tourism-rich areas and industrial cities. And this product is very useful for organizations set up to protect the global environment.

So, we have a wide range of markets and after successfully implementing our product, we will give good publicity about our product through online platforms as well as through recognized scientific journals.

In this outdoor system, initially, we will manufacture this only for the orders we receive because this involves considerable cost. After we finished about 100 Systems, we hope to mass produce this as well.

Technical Overview and Implementation

- Algorithm

  - Our mechanism is somewhat simple in a theoretical way. As CO_2 and toxic gases absorb IR rays we transmit IR rays within a specific frequency range with pre-defined power. On the receiver end, we again capture those rays and measure the power loss or concentration loss of the transmitted rays. From the deviation of relevant parameters (power loss or concentration loss of the transmitted signal), we could calculate the amount of CO_2 and toxic gases concentration.

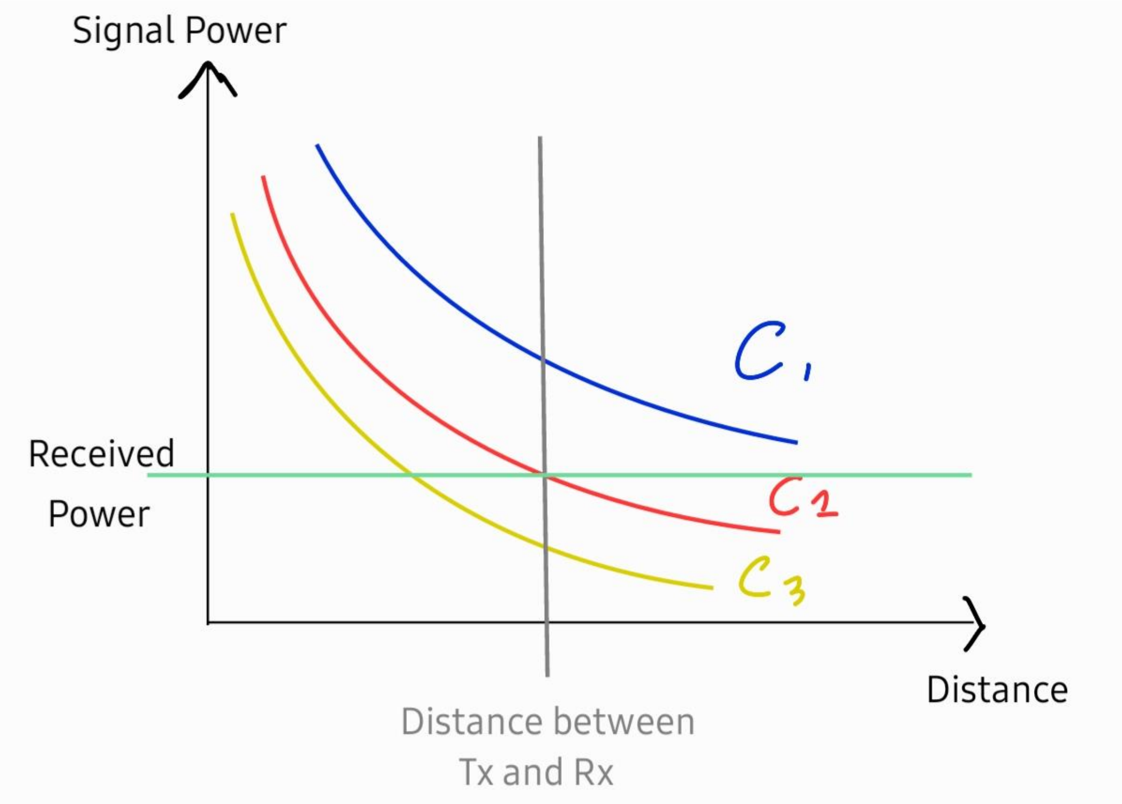
- Problems

  - CO_2 and toxic gases are not the only things that could absorb the IR rays. The water vapor is in a considerably large concentration than CO2 and other toxic gases to absorb IR rays.

    - To overcome this problem, we did an analysis of wavelengths of IR rays that are affected by CO_2 as well as water vapor. And we found that **CO_2 and other toxic gases absorb more rays around the wavelength of 15,000nm**. And water vapor absorbs rays from wavelength 700nm to 80,000nm.
    - So, we transmit two signals,

- One around a wavelength of 15,000nm (These rays are affected by both CO_2 and Water vapor)
- One around a wavelength of 40,000nm (These rays are only affected by water vapors)
- The signals are transmitted from one transmitter and received from several receivers in several places at a pre-determined distance.
    - So, by taking repetitive measurements gain from the receivers and with the use of statistics we gain from those data, we can calculate the mean concentration of CO_2 over a specific area.

- The next thing is Channel Impairments
    - As we said earlier, even though our algorithm is somewhat simple in a theoretical way, in practical implementation we have to deal with distortion, attenuation, and all other interference.
        - We develop statistical graphs gain from several experimental data.
        - To attain a relationship between the required parameters we also try to use some reference points in our statistical graphs.



With the interception point we can get the CO2 Concentration

- Technology and platform
  - We are planning to develop our final product using raspberry pi using some advanced computer vision techniques by using aided programs to conduct advanced mathematical solutions.
- Further implementation
  - For the better usage we can develop a mobile application which gives the state or the nature of the atmosphere surrounding in our current location.
  - If the implementation succeeded, we can extend up to detecting the concentration of the gases globally by transmitting the signals using the relevant satellites.

User Scenario

Our product deals with working in two scenarios.

1. For an outdoor area, the transmitter could be fixed in a specified tower and other receivers are also fixed in specific areas. While the transmitter sends the signal, and the receiver detects the signal and informs the relevant organizations.
2. Second one is for indoor purposes. Like before we stated concentration of CO_2 may change in a prominent manner in indoors. therefore, to detect these changes both the transmitter and the receiver ends are mounted in the walls and from the detection of rays the change of concentration of CO_2 can be easily detected.

Team Details

.

Ravindu Pushpakumara
200035502948
ravindumadushan005@gmail.com
+94 76 398 3406

Arunan Vishagar
200020803499
Vgr0876@gmail.com
+94 76 606 2499

Hansa Marasinghe
200017301128
mmhnbm@gmail.com
+94 70 375 2620