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IoT and Machine Learning for Identifying Correlation between Factors Causing Climate Change

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ARTICLE INFO	ABSTRACT
	The global climate is changing due to anthropogenic activities such as industrialization, infrastructure development, deforestation etc. Expected effects of climate change include increase in global temperatures, rising sea levels, changing precipitation, melting of glaciers, less snowfall, expansion of deserts etc. Most ecosystems are affected by manmade climate change and Mount Everest is no exception. This paper delves into the effects of global warming on Mount Everest and how Internet of Things (IOT) can be used to correctly monitor these effects. The IOT system will take three parameters temperature, carbon parts per million in the atmosphere and snowfall. This research paper also proposes a IOT framework to measure the net snowfall. The data gathered by the IOT system will be used to create a model will be created to monitor the effect of temperature and carbon parts per million on snow fall. .

1. Introduction

In past few decades the indicators of global warming has linked with the Everest and glaciers in mountain regions. A surface temperature reconstruction based on the response of glaciers to climate change indicates that the Himalaya and surrounding areas have warmed by approximately 0.68C since the middle of the 19th century. If current patterns keep up, most of the glaciers covering the Himalayas could melt within the next 50 years; 80 percent will be gone within 30 years [2]. Some of these glaciers are three miles long. Mount Everest would then appear as an enormous peak of mostly exposed rock with limited areas of ice. The glacier used as Hillary and Norgay's original base camp has moved three miles in 20 years while others have disappeared entirely. The rising temperatures in the Himalayas are also leading to more avalanches.

To correctly measure the effects of global warming on Mount Everest this research proposes an I.O.T Framework which will measure the annual temperature, average snowfall and carbon emission in Gokyo Region. The data collected by the system will be fed in to a prediction model which will predict the severity of the effects if current trend is to continue.

2. Factors Causing Climate Changes

This research walks through various keys which help in exploring the causes of climate change in Himalayan regions. With the factors discussed below research also discusses the correlation of these factors in causing climate change.

(1) Carbon Emission
(2) Temperature

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(3) Measure of Snowfall

2.1 Carbon Emission

6.73 percent (1,781,792) out of total population of Nepal live in Mountain region. Every year around 1,000,000 tourists visit Nepal. We can assume a high percentage of tourists visit the Mountain areas. Solukhumbu District has a total population of 105,886 [1]. The Population of Tourists *(T)* visiting Khumbu Region every year, population of Solukhumbu *(P)* is directly responsible for carbon emission. Solid waste produced by the local residents *(SW_P)*, waste by livestock *(SW_L)*, trekkers and mountaineers *(SW_M)* also causes huge amount of carbon emission. An average human exhales 2.3 pounds of carbon dioxide on an average day [3].

Considering the above elements we can define a formula to calculate *Carbon Emission (CE)* occurs in Himalayan belt:

$CETotal =$ $CET + CEP + CESW_P + CESW_L + CESW_M$

2.2 Temperature

Emission of Carbon, Carbon Dioxide, other air pollutants and greenhouse gases collected in the atmosphere absorbs sunlight and solar radiation. This causes the temperature to increase. There aren't any such researches or data which has identified the shift in temperature with basis of carbon emission. With the proposed implementation model of this research the IOT Devices will help to collect the data for carbon emission and shift in temperature. With the data of sometime length collected via IOT devices our machine learning models can analysis the behavior between carbon emission and change in temperature.

2.3 Measure of Snowfall

Snowfall is a natural phenomenon. The decrease and increase of snowfall is also natural but this factor can be related with increase in temperature and the amount of carbon in the atmosphere. This can be calculated with the gradient to the point with no snow. This point will be a basis to calculate the net snowfall. The point will be x meters away from the device the initial gradient will be Θ_0. The device will be at the height of y_0 from the surface. After the snowfall the gradient will be increased to Θ_1. After the snowfall the new height will be calculated by the formula:

$y_1 = x / \tan (\Theta_1)$

The snowfall will be calculated by using the formulas:
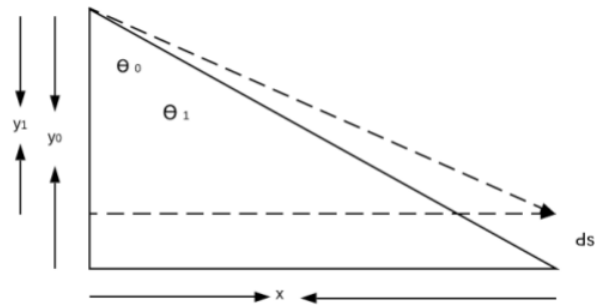
$ds = y_0 - y_1$

$ds = y_0 - x/ (\tan\Theta_1)$

Figure 1. Measurement of Snowfall

3. Internet of Things Fundamentals

Fundamental of IOT will be highlighted in this section. The fundamentals highlighted in this section will be adapted in the development of IOT Framework. The framework will further be used to identify the correlation between factors causing climate change.

3.1 Internet of Things

IOT is an interconnected system of web enabled smart devices that collects, sends and acts on acquired data. IOT resembles the computing devices such as sensors, microcontrollers & wearables to perform in a ubiquitous environment.

3.2 Sensors in IoT

Sensors are important computing devices which enables pervasiveness in an IOT System. Sensing Layer of the IOT Architecture deals with sensors which interact in a IOT system. Sensors receives streams of data from physical world and feds those raw data to the server. Audio Sensors, Magnetic Sensors, Light Sensors, GPS Sensors, cameras, Motion sensors are some example of sensors. Carbon Emission Sensors, Infrared Sensors & Heat Sensors will be used for this research.

4. Proposed IOT Framework for Crowdsourcing Data

Section II identifies the factors and objects causing climate change. Also it describes that the data should be gathered from mountain belt as well as the residential area of Himalayan region. Framework below provides a representation of using IOT Sensors in different areas like Mountain Belt and Residential Areas. Data such as the temperature and carbon emission are received from both residential areas and mountain belt. Local residents and trekkers both emit carbon. Sensors such as infrared sensors are only

installed in the mountain belt. These sensors will measure the difference in snow after each snowfall. Data will be gathered to a remote server via wireless sensing networks. Those data are then provided to the central storage server. At central storage machine learning algorithms will process those data for analyzing the correlation between three factors causing climate change.
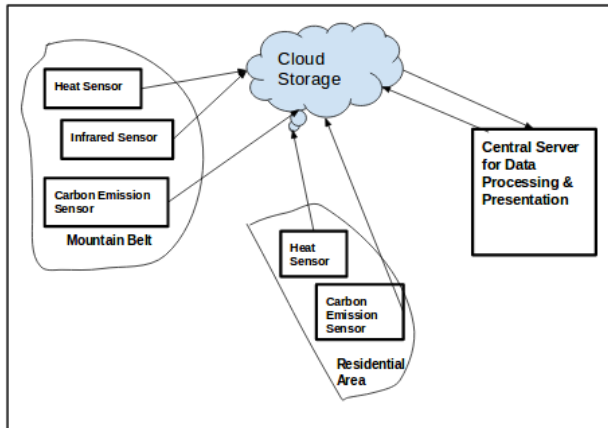

Figure 2. Proposed IOT Framework

5. Methodology

The *temperature data, carbon emission data* and *net snowfall data* gathered by the I.O.T system will be fitted in to a machine learning algorithm. The datasets will be prepared based upon the data retrieved from IOT Devices. Also a training data set will be prepared. The model will use *K-Nearest algorithm* for processing the input datasets. The 'temperature' and 'carbon emission' will be the feature to our model. The snowfall will be the label. The model will predict the average snowfall according to the temperature and carbon emission.

6. Limitations

The framework proposed in this research limits developed considering only three factors causing climate change. Due to the unavailability of research and data the framework might not suffice processing extra parameters. A detailed field study of Himalayan belt in Everest region should be done in order to estimate the field of investigation. This will then highlight the infrastructural needs for implementing the framework. The proposed framework will be implemented in the mountain region around Khumbu region. So the ideal sensors that will be used in normal experiments will lag to function up on that altitude with primitive temperature. The battery drainage will be a major problem in running the sensors always. The Machine Learning model developed is solely dependent upon the data generated from IOT Devices. Neither the IOT Framework, nor the Machine Learning Model is tested due to unavailability of data. So the accuracy of identifying the correlation between three factors causing climate change can vary.

7. Conclusion

The framework proposed for identifying the correlation between three different factors causing climate change has challenging limitations. Upon successful implementation of this framework, it can provide valuable data to different organizations such as environmental, geological & meteorological departments. Identifying the factors and their roles in causing the climate change, we can parameterize a standard for carbon emission. This can apply to the trekkers and to the local residents in limiting their use of goods that consumes high carbon. Limiting the carbon emission can help reduce the global warming.

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