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[ICRTCET-2018]

ISSN 2348 – 8034
Impact Factor- 5.070

GLOBAL JOURNAL OF ENGINEERING SCIENCE AND RESEARCHES

SNOW AVALANCHE WARNING SYSTEM FOR BAHANG REGION IN HIMACHAL PRADESH

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ABSTRACT

India is the home to one of the youngest mountain ranges, Himalayas, which encompasses a huge area of the North and North East India. Avalanches are normally observed in the regions of Jammu and Kashmir, Himachal Pradesh, Uttarakhand, etc. All the regions having avalanche activity are populated and hence there is an increasing need to provide the avalanche occurrence information to the locals residing in these areas as well as the tourists. The present research proposes a way to communicate this avalanche occurrence information to the public for the region of Bahang in Himachal Pradesh. A web portal is proposed in the current study that will provide the public an access to avalanche information by using the meteorological parameters for that particular day. The proposed system is created using the Django framework which incorporates Nearest Neighbour Algorithm with cosine similarity to find whether a particular weather situation may lead to an avalanche.

Keywords: *Avalanche, Cosine Similarity, Disaster Warning system, Forecasting, Nearest Neighbour.*

I. INTRODUCTION

Snow avalanche is a natural disaster that is mainly observed in the mountainous terrain all over the world. Even in India, the north and the north eastern states have a history of occurrence of avalanche. Avalanches are type of fast moving mass movement over the slopes of the mountain[1]. These contain of ice, rocks, soil, vegetation, etc[2]. An avalanche mainly occurs when the snowpack is not able to sustain the force applied on it. This leads to a mechanical failure in the snow pack and the snow breaks and start sliding down the surface. The avalanches are not always naturally triggered and can also be triggered by human intervention. In either of the case, the forecasting of avalanche is needed for the protection of people staying close to the avalanche prone areas. There are many institutes working towards the forecasting of snow avalanche. Avalanche forecasting was the suggested by the use of nearest neighbour algorithm to obtain the avalanche probability[3]. This was further implemented by using the Euclidean distance as a distance metric to find the closeness between the days[4]–[6]. Variations based on nearest neighbour models have also been proposed for avalanche forecasting[7]–[9]. In India, eNN10 model was developed for the forecasting of snow avalanche[10].

Though avalanche forecasting has developed a lot since its inception, proper access to this avalanche occurrence information is still not present. Further, circulation of this information through proper channels is also needed to make sure adequate warning is received by the people residing near the avalanche prone areas, tourist and adventure enthusiasts who are present in these areas. Lack of means in the public domain is observed in case of such avalanche warning systems in India.

In Switzerland, an Avalanche warning system was established that obtained the data from various stations and used the various applications like snowpack module, regional forecasting module, etc. to obtain the avalanche forecast and then allowed public to access this information via internet or obtain it by fax or email[11]. Meteorological Service of Canada collaborated with the Canadian Avalanche Centre to provide avalanche warnings through a password-accessed website[12]. An avalanche disaster monitoring and early warning system was presented that provided snow avalanche danger map and snow avalanche early warning report to the user for the area along the Tianshan Highway[13]. Norwegian Avalanche Centre launched a national avalanche warning service which provided bulletins assessing the avalanche danger on its web portal to avoid accidents and reduce the problems due to avalanche[14]. Present study proposes a snow avalanche warning system that can provide

avalanche occurrence information to the public through a web portal. The model is currently developed by using the data of Bahang region in Himachal Pradesh, India.

II. STUDY AREA AND DATA CHARACTERISTICS

The region that we have used for the present study is the Bahang Village which is present in the Kullu District of Himachal Pradesh. The analysis of the weather conditions of Bahang for the year 1976 to 2011 showed a decreasing trend for snowfall and increasing trend for maximum and minimum temperature[15]. Fig. 1 presents an overview of Bahang Region.

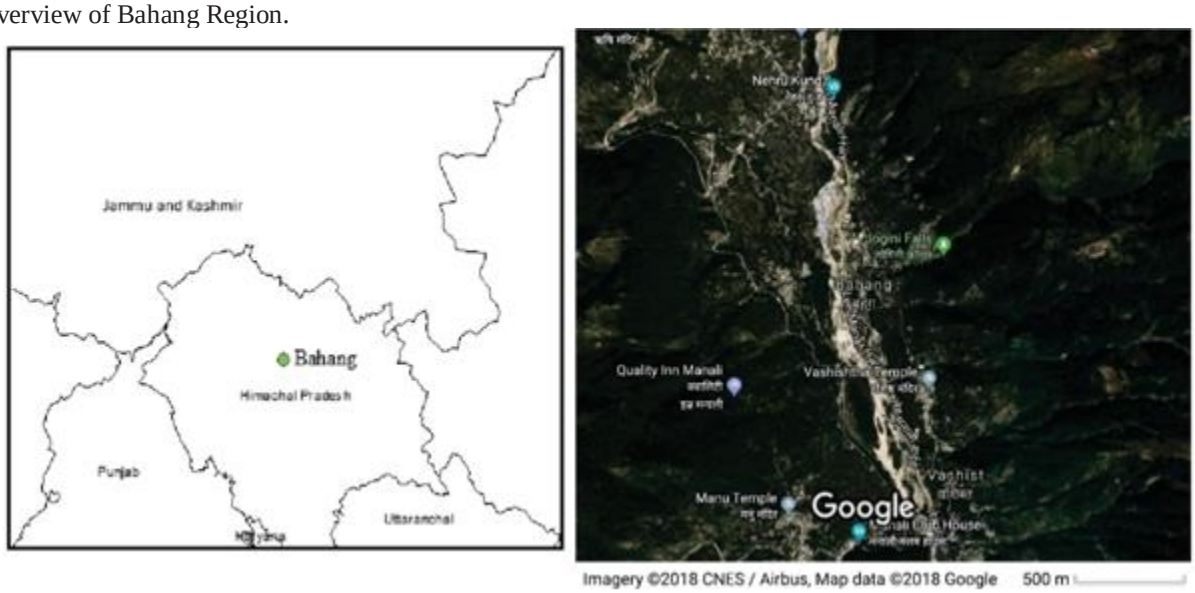

Figure 1 : Study Area - Bahang

For the proposed model, the parameters that are used for forecasting avalanche condition are obtained from the observation station installed at Bahang (2192 a.s.l.) by Snow and Avalanche Study Establishment(SASE). A total of 22 snow and meteorological variables were obtained from the station on daily basis at 0830 hrs and 1730 hrs (both IST (GMT + 5.30)) . The data was taken for the year 2005 to 2013 for the months of January, February and March. Out of these, for our proposed model, 10 parameters are used. The list of parameters used for the present work are given in Table 1. For our proposed model, the data from the years 2005 to 2012 was used to train the avalanche forecasting model. Data of the year 2013 was used to check the working and accuracy of the system.

Table 1:list of parameters considered

Sr. No	Variable	Unit
1	Wet Temperature	°C
2	Average wind speed	kmph
3	Humidity	%
4	Amount of fresh snow	cm
5	Rate of snow fall	cm/min
6	Fresh snow water equivalent	mm
7	Height of snow	cm
8	Snow Temperature	°C
9	Snow Penetration	cm
10	Sunshine	Hrs: min

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III. METHODOLOGY

The proposed system is developed in python using the Django framework. Fig. 2 provides the basic layout of the proposed system. Fig. 3 provides the block diagram of the proposed model. The web portal will retrieve the location of the area depending on the cursor position of the mouse. The values of snow and meteorological parameters of the present day for that region will be fed to the proposed model. By using the avalanche forecasting model proposed by[16], the avalanche situation for a particular day will be found by the proposed model. The algorithm used in the proposed model uses the concept of cosine similarity with NN to find whether an avalanche can occur on a particular day. The concept used here is that if an avalanche had occurred for a certain weather condition, then presence of similar weather condition in the future may again lead to an avalanche. The basic steps of the avalanche forecasting model using cosine similarity with nearest neighbours are as follows:

a. Calculate Cosine Similarity between the present day (Day to be forecasted) and the past days in the dataset by using the equation

$$\text{Cosine Similarity} = \frac{\sum_{i=1}^{n} A_i B_i}{\sqrt{\sum_{i=1}^{n} A_i^2}\sqrt{\sum_{i=1}^{n} B_i^2}} \quad (1)$$

where A and B are two vectors and Ai and Bi are its components respectively.

b. Sort all the past days in descending order with respect to their cosine similarity value with the present day.
c. Consider the first N nearest neighbours from step 2.
d. Note the avalanche condition for all N days.
e. Calculate probability of avalanche occurrence p(A) by □ □ , where nA is the number of avalanche days amongst the neighbours.
f. If p(A)>=threshold, day is an avalanche day

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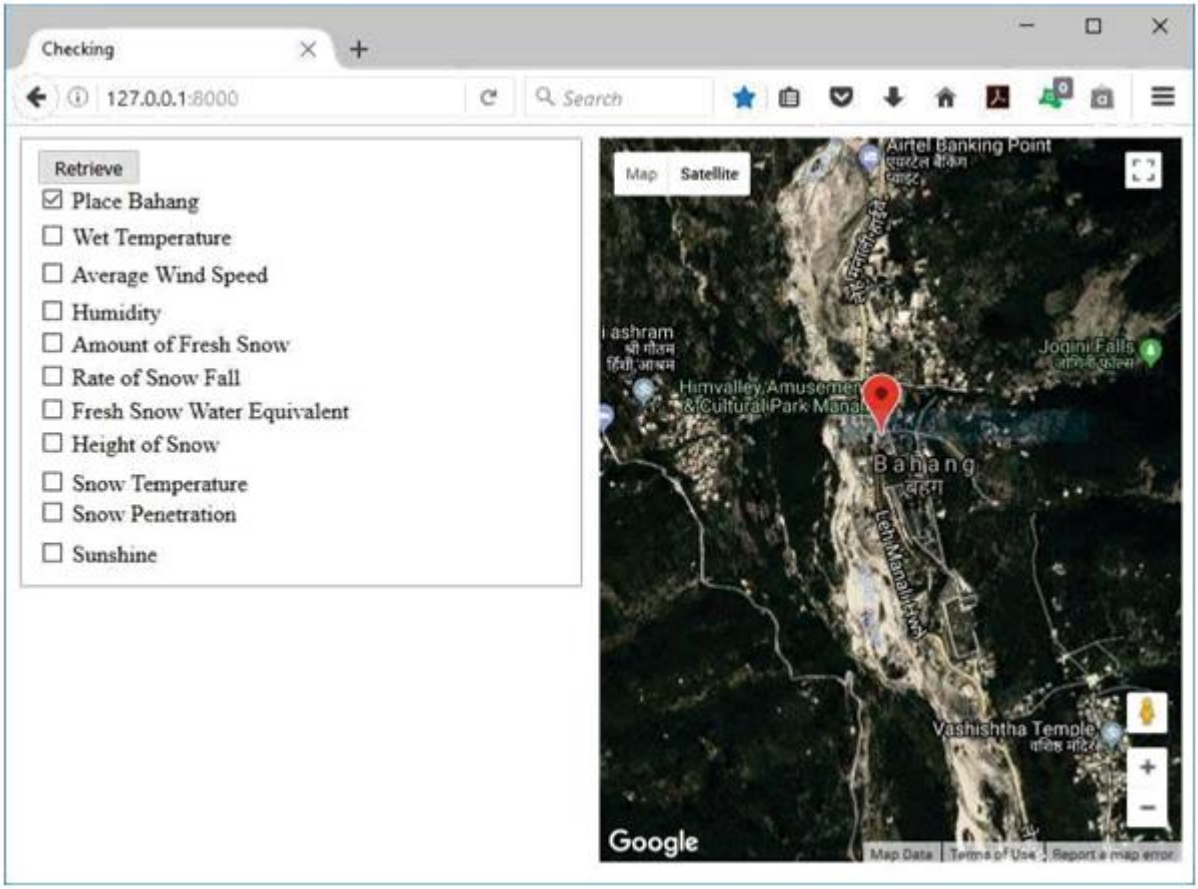

Figure 2:Basic Layout of Proposed System

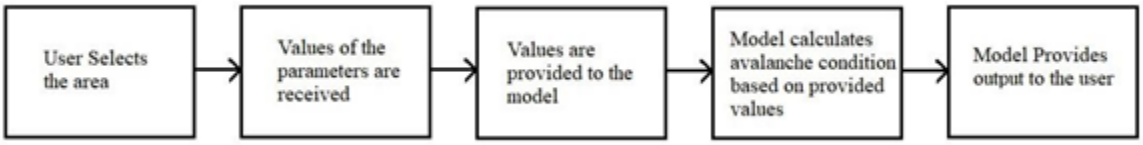

Figure 3:Block diagram of Proposed model

For our model, the value of N is 10[6] and the threshold value is 0.3[5] i.e. if at least 3 out of 10 neighbouring days are avalanche days then the particular day is considered as an avalanche day. After calculating the avalanche condition for the present day, it is provided to the user. Fig. 4 shows the output format provided by the proposed model. Hence the proposed model can provide the avalanche occurrence information by using avalanche forecasting model based on cosine similarity with nearest neighbour. However, the past records for that area will be needed by the model for training the model for that region. For the proposed study, data from the year 2005 to 2012 was used to train the avalanche forecasting model. The proposed model will also provide information about the history of avalanche occurrence in the area. This will help the user to get information about the regions that are avalanche prone in the area.

IV. CONCLUSION

The proposed model will be able to provide avalanche information depending on the values of the weather parameters for the present day through the use of a web portal. Currently this model has been developed by taking

data of Bahang region from Himachal Pradesh. However, the model has the ability to extend its use for any region provided the past weather information for that area is provided to the model. Future enhancement is proposed by integrating the real time weather data from government institute in the said system for the whole mountainous terrain that would enable the user to simply select the region and the system would automatically provide the probability of occurrence of avalanche

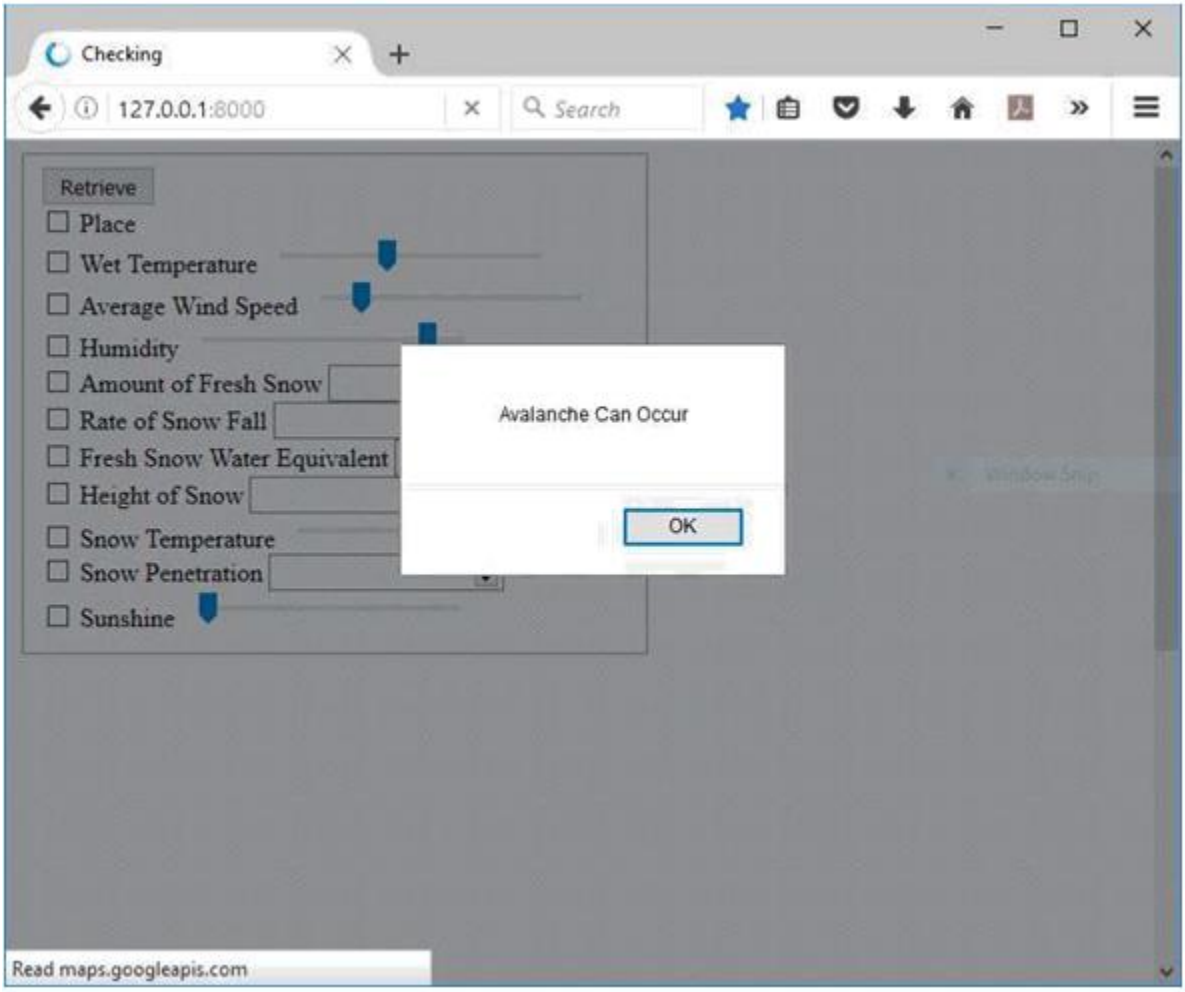

Figure 4:Output Format for proposed model

V. ACKNOWLEDGEMENT

The Authors are thankful to Director, SASE for providing us with the snow and meteorological data for Bahang, Himachal Pradesh for our research study purpose

REFERENCES

1. *Jürg Schweizer, Perry Bartelt, and Alec van Herwijnen, "Snow Avalanches," in Snow and Ice-Related Hazards, Risks and Disasters, Elsevier, 2015, pp. 395–436.*
2. *Jurg Schweizer, J. Bruce Jamieson, and Martin Schneebeli, "Snow Avalanche Formation," Rev. Geophys., vol. 41, no. 4, 2003.*

3. *Charles Obled and Walter Good, "Recent Developments of Avalanche Forecasting by Discriminant Analysis Techniques: A Methodological Review and Some Applications to the Parsenn Area (Davos, Switzerland)," J. Glaciol., vol. 25, no. 92, pp. 315–346, 1980.*
4. *O. Buser, "Avalanche forecast with the method of nearest neighbours: an interactive approach," Cold Reg. Sci. Technol., vol. 8, no. 2, pp. 155–163, 1983.*
5. *O. Buser and W. Good, "Avalanche Forecast: Experience Using Nearest Neighbors," in Int. Snow Science Workshop, Aspen, Col, Aspen, Colardo, 1984, pp. 109–115.*
6. *Othmar Buser, Monika Butler, and Walter Good, "Avalanche forecast by the nearest neighbour method," Int. Assoc. Hydrol. Sci. Publ., vol. 162, pp. 557–569, 1987.*
7. *R. . Purves, K. . Morrison, G. Moss, and D. S. . Wright, "Nearest neighbours for avalanche forecasting in Scotland—development, verification and optimisation of a model," Cold Reg. Sci. Technol., vol. 37, no. 3, pp. 343–355, Nov. 2003.*
8. *C. McCollister, K. Birkeland, K. Hansen, R. Aspinall, and R. Comey, "Exploring multi-scale spatial patterns in historical avalanche data, Jackson Hole Mountain Resort, Wyoming," Cold Reg. Sci. Technol., vol. 37, no. 3, pp. 299–313, Nov. 2003.*
9. *P. Cordy, D. M. McClung, C. J. Hawkins, J. Tweedy, and T. Weick, "Computer assisted avalanche prediction using electronic weather sensor data," Cold Reg. Sci. Technol., vol. 59, no. 2–3, pp. 227–233, Nov. 2009.*
10. *A. Singh, B. Damir, K. Deep, and A. Ganju, "Calibration of nearest neighbors model for avalanche forecasting," Cold Reg. Sci. Technol., vol. 109, pp. 33–42, Jan. 2015.*
11. *T. Russi, W. Ammann, B. Brabec, M. Lehning, and R. Meister, "Avalanche Warning Switzerland 2000," in Early Warning Systems for Natural Disaster Reduction, Berlin, Heidelberg: Springer Berlin Heidelberg, 2003, pp. 569–577.*
12. *G. Statham and A. Jones, "The backcountry avalanche advisory: Design and implementation of a new public avalanche warning system in Canada," Proc ISSW Telluride Co, 2006.*
13. *X. Liu, Y. Liu, L. Li, and Y. Ren, "Disaster monitoring and early-warning system for snow avalanche along Tianshan Highway," in Geoscience and Remote Sensing Symposium, 2009 IEEE International, IGARSS 2009, 2009, vol. 2, p. II–634.*
14. *R. V. Engeset, "National avalanche warning service for norway– established 2013," in Proceedings ISSW, 2013, pp. 301–310.*
15. *H. S. Gusain, V. D. Mishra, and M. R. Bhutiyani, "Winter temperature and snowfall trends in the cryospheric region of north-west Himalaya," Mausam India, vol. 65, no. 3, pp. 425–432, 2014.*
16. *Neha Ajit Kushe and Dr. Ganesh M. Magar, "An alternative approach with nearest neighbour classifier for forecasting snow avalanche," Int. J. Comput. Eng. Appl., vol. 12, no. 2, pp. 79–85, Feb. 2018.*