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How to Reduce Traffic Jams when Flood Happens

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Abstract. Most map applications play the job of navigating users and informing them of traffic jams. However, they often cannot deal with an emergent situation when a disaster such as a flood takes place. This paper aims at providing a solution for map and navigation applications how to ensure users' safety when natural disasters of floods happen. The subject uses sensors, programming, and perceptrons to prompt the study and take the Beijing-Hangzhou canal as a sample since each river has its warning water levels. Nevertheless, this paper provides a solution to the research aim, no experiments are involved.

Keywords: flood risk, traffic, GPS.

1. Introduction

Every year, floods take place in the rainy season. They may lead to huge disasters or even casualties. It is a difficult problem to evacuate people and cars in that situation.

The Beijing-Hangzhou canal has over a thousand years history and still plays a significant role in nowadays' water transport. Nevertheless, a long stretch of it is located in southeast China, where flood often takes place during the plum rain season around June and July. The senior high school of the author is located on the bank of the canal, so it is an annoying problem to get to school when a flood happens and submerges the road, while it is rush time that a traffic jam always happens since most of the students get there by car. Urban regions have a rapid increase in both the risk and exposure to hazards due to the concentration of people and money, depletion of resources, changes in the environment, and human activity. One issue made worse by urbanization is urban flooding, which affects output and the way of life of the urban people both directly and indirectly [1].

Traditionally, google maps or applications connected to the GPS can provide a route costing the least time if there is an accident or blocking caused by too many cars. The most popular locating and navigational instrument in use today is the global positioning system (GPS). GPS has numerous uses in the geosciences, surveying, mapping, transportation, agriculture, and military planning. Any specific GPS location's positional and elevation accuracy, however, is subject to error for a variety of reasons. For some applications, like real-time navigational systems, this has significant ramifications. With more information, maybe from several sources, and especially from numerous receivers, GPS accuracy can be considerably increased. Spatial data can be used to significantly improve the location and elevation of a single GPS device. In order to intelligently align the GPS location for vehicle tracking with a road centerline, map matching can be used, and height assisting can supplement the GPS solution by using a digital terrain model (DTM), hence lowering the number of satellites needed to calculate a position [2]. However, they cannot come up with a solution at a time when a flood or other natural disaster suddenly

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happens. The specific objective of this study was to provide a solution to applications to act correctly when an emergency happens.

The thesis provides an idea and a general solution. It does not engage with practically personal data collection or experiment due to the weather condition and lack of license to get involved in any official applications or setting devices.

2. Previous research

Most map applications have been connected to GPS or other satellite navigation systems, so it is an easy job for them to detect the current traffic flow. If a traffic jam is happening, they can provide several choices for users to choose from and to let them spend less time and arrive at their destination more quickly. However, they are often not flexible enough to deal with sudden natural disasters time. For situational awareness and decision support, flooding maps are essential. However, conventional approaches like eyewitness accounts, remote sensing, and hydrology models might not be able to keep up with the quickly altering urban hydrological environment [3].

3. Analysis

Sensors are used to detect water levels near the bank of the canal, and data on former water level records are also collected to determine a warning water level. To determine whether the flood will happen, a perceptron is required.

4. Previous precautionary measures

Weather reports can be a reference used for the former prediction. During the rainy season, the possibility of causing a flood is greatly increased for too much rain will increase the amount of water. Applications can be connected to weather bureaus, so they can receive real-time weather reports and calculate reasonable results. If an emergent warning of a coming rainstorm is presented by the weather bureau, applications should inform users to try to avoid taking roads along rivers with a large volume and high water level, or roads with large traffic flow, and provide several backup solutions for them, such as another route which can reach the destination or simply warn of not going. There is also a simpler way that the GPS system can be directly used for the weather prediction. A new and possibly important upper-air observing system for meteorological organizations and scholars worldwide has resulted from this completely unexpected application of GPS. The integrated (total column) precipitable water vapor estimation above a fixed location is the first and most established application of GPS for this purpose. The methods utilized by the Forecast Systems Laboratory (NOAA/FSL) of the National Oceanic and Atmospheric Administration to gather, analyze, and disseminate GPS water vapor observations are currently mature and almost ready for operational usage. The effectiveness of using GPS-integrated water vapor data for both objective (i.e., numerical weather prediction) and subjective weather forecasting has been demonstrated by NOAA/FSL [4].

According to the data collection and previous research, the normal water level of the Beijing-Hangzhou canal at Gaoyou, Jiangsu Province segment is around 8.00m, while the warning water level is around 9.46m, which means that it is safe if the level is lower than the critical water level of 9.46m when the level is higher than the warning level, it is greatly possible to lead to a consequence of flood if water cannot be drained away in time.

In this situation, sensors should send a warning message to applications. Combined with the traffic condition of the traffic flow and the exhaust velocity, applications can come up with the longest time for users to leave the current route.

When a flood happens, water can also be drained away by the urban sewerage system. Therefore, a flood can be delayed and will not last for a very long time or even drained away by underground tubes, so drivers may have a longer time to evacuate from the flooding place. Nevertheless, to avoid accidents happening, drivers usually choose to drive at a relatively lower speed, which often leads to traffic jams. Combining these two current conditions, applications calculate a reasonable period for users to leave their current route, switch to a relatively safer route, or simply abandon their transportation and rush to a safer place.

A perceptron is used to determine whether a flood will happen. The inputs are water level and draining speed. The output shows whether the flood will take place. If it is likely that the flood is coming, the output is 1. By contrast, if the flood will not happen or can be prevented by the drainage system, the output should be -1. Here, we demonstrate a two-layered network of linear neurons that self-organizes in response to a collection of patterns that are displayed. The net converts the entire information contained in a pattern into mutually independent features after the learning process is complete. A Hebbian learning rule is followed by the synaptic weights between layers. For lateral, hierarchically ordered weights within the output layer, we suggest a local anti-Hebbian rule. The rule pushes the output units' activities to become uncorrelated and the lateral weights to disappear in order to choose the learning parameters properly. The network conducts a principal-component analysis of the input data [5]. The weights between the two layers converge to the eigenvectors of the covariance matrix of input patterns.

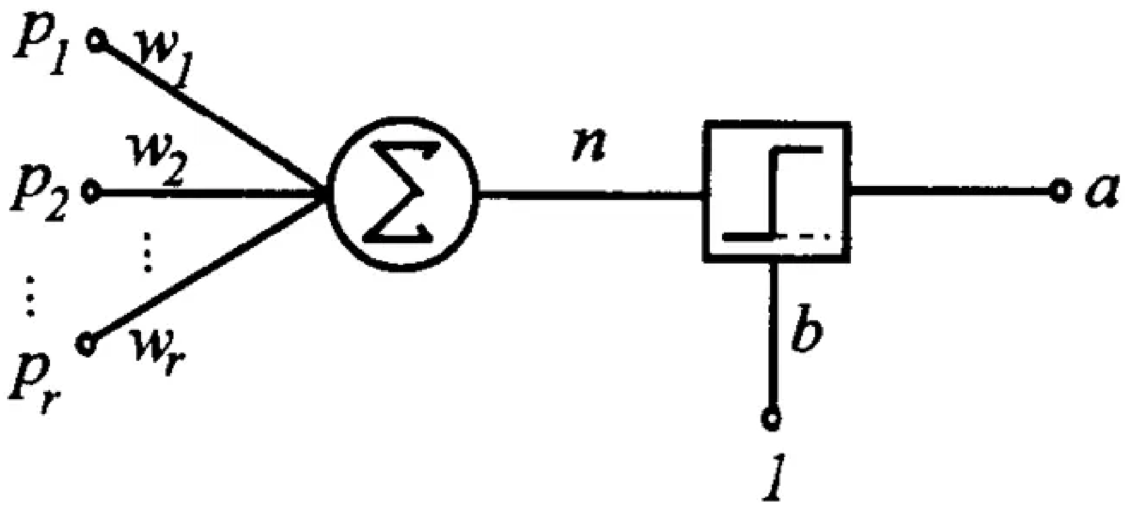

Figure 1. Perceptron[4]

Figure 1 shows the basic operating principle of the perceptron, which is a simple model of a neural network and also a linear classifier. It can be trained by inputting sample data and gives two types of outputs. We give it two inputs water level and draining speed. The inputs each will be multiplied by a weight and then add with a bias through a linear function of $f(x) = \mathrm{sign}(w1 \times x1 + w2 \times x2 + b)$. If the calculating result is a positive number or 0, the output of the perceptron is 1, which means that the flood cannot be stopped immediately and has a great possibility to take place shortly. If the result is a negative number, the output is -1, which means that the flood will not happen or water can be drained away by drainage systems underground.

Not the whole area nearby the river will be submerged at the same time. There are still parks and hills at the bank so the terrains may go ups and downs. Therefore, places with a relatively low altitude have the greatest possibility of submerging. Sensors can be put in the river near those areas and inform drivers who are staying in those places preferentially.

Users' feedback, such as their real-time leaving paths, returns to applications. The information travels through the network layer of the Internet. The network layer, which sits between the transmission layer and the data link layer in the OSI reference model, is the third layer. The data link layer's transmission function between two neighboring endpoints is used to further manage data communication in the network, and it tries to send data from the source end to the destination end through a number of intermediary nodes. This offers the transport layer the most fundamental end-to-end data transfer service. The unstructured peer-to-peer (P2P) networks and anonymity-providing networks are two groups of systems that have been studied previously and are relevant to the network layer of blockchain systems. In order to share information among participating peers, permissionless blockchain systems rely on a public P2P network. All peers must be aware of the set of information on which the consensus layer depends for proper operation (e.g., blocks and transactions). The necessary information is spread throughout the network's peers via flooding or gossip methods. This turns permissionless blockchains' network layers into unstructured P2P networks, which have been around for a long time and have undergone substantial analysis, largely from the standpoint of performance or using adversary models that do not correspond to the danger to blockchain systems [6].

In that case, applications should provide them with a correct escape route and correctly direct them to a safer place, the route should also keep updating according to the real-time change around users. For example, applications can suggest users turn to another road when they are at a T-junction through the GPS application. If users are detected not acting in any movement, they can be determined ignoring the warning. Then applications should keep sending warning messages and informing them of the possible danger until they make their move. During that time, solutions for solving this problem such as escape routes should be updated due to the change of environment around users, such as the area and roads being submerged and in traffic flow.

We can know that satellites and GPS systems have the ability to distinguish terrain and elevation. Therefore, places with a higher altitude should be firstly suggested. It is described how to create precise, spatially dense 3-D terrain displacement velocity maps. It is based on the combination of terrain displacement velocities calculated from time series of interferometric synthetic aperture radar (InSAR) data recorded along ascending and descending orbits, as well as from repeated GPS observations. The technique makes use of GPS data of the horizontal velocity and chosen persistent scatterers (PSs). The suggested method's reduction of the effect of air phase delay on InSAR data is a crucial step. It is demonstrated that if smooth horizontal velocity changes can be assumed, precise vertical velocities at PS locations may be recovered. A more spatially regular 3-D velocity map is produced as a result of the reduction of air influences, which also reduces the spatial dispersion of vertical velocity estimations [7]. Figure 2 shows the basic working process of the system.

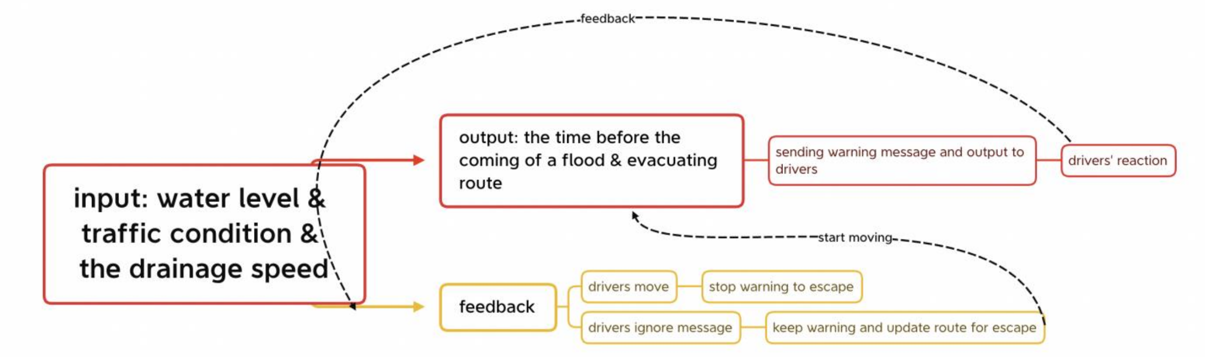

Figure 2. Running Process[6]

5. Further study

On the 20, July 2021, a big sudden flood happened in Zhengzhou, China. At that time, people in subways were submerged, while 398 people were submerged to death and 8 people were lost. For those underground facilities, their broadcast can be connected to sensors. If sensors detect that the water level is too high and the output of the perceptron shows that a flood is on the way, the broadcast can inform staff to stop working and ask staff and passengers to evacuate. Since broadcast systems are using an IP network, sensors can be connected to routers on the network layer. Nevertheless, this is still a hypothesis since the government controls public broadcasts that ordinary people cannot involve in.

6. Conclusion

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This paper provides an idea and a possible solution for a flood during a traffic jam with the application of the GPS system and the Internet. By combining the weather and traffic conditions, we can monitor the water levels of rivers and use perceptrons to give a reasonable method to reduce the tragedies brought by floods. Nevertheless, further experiments and calculations are lacking due to the limitation of the time period, the dry season, and the lack of official licenses. In the future study, the set of experiment devices, such as sensors and transducers is required.

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