A Preliminary Study on Algo Float Trajectory Prediction using Multimodal Convolutional LSTM

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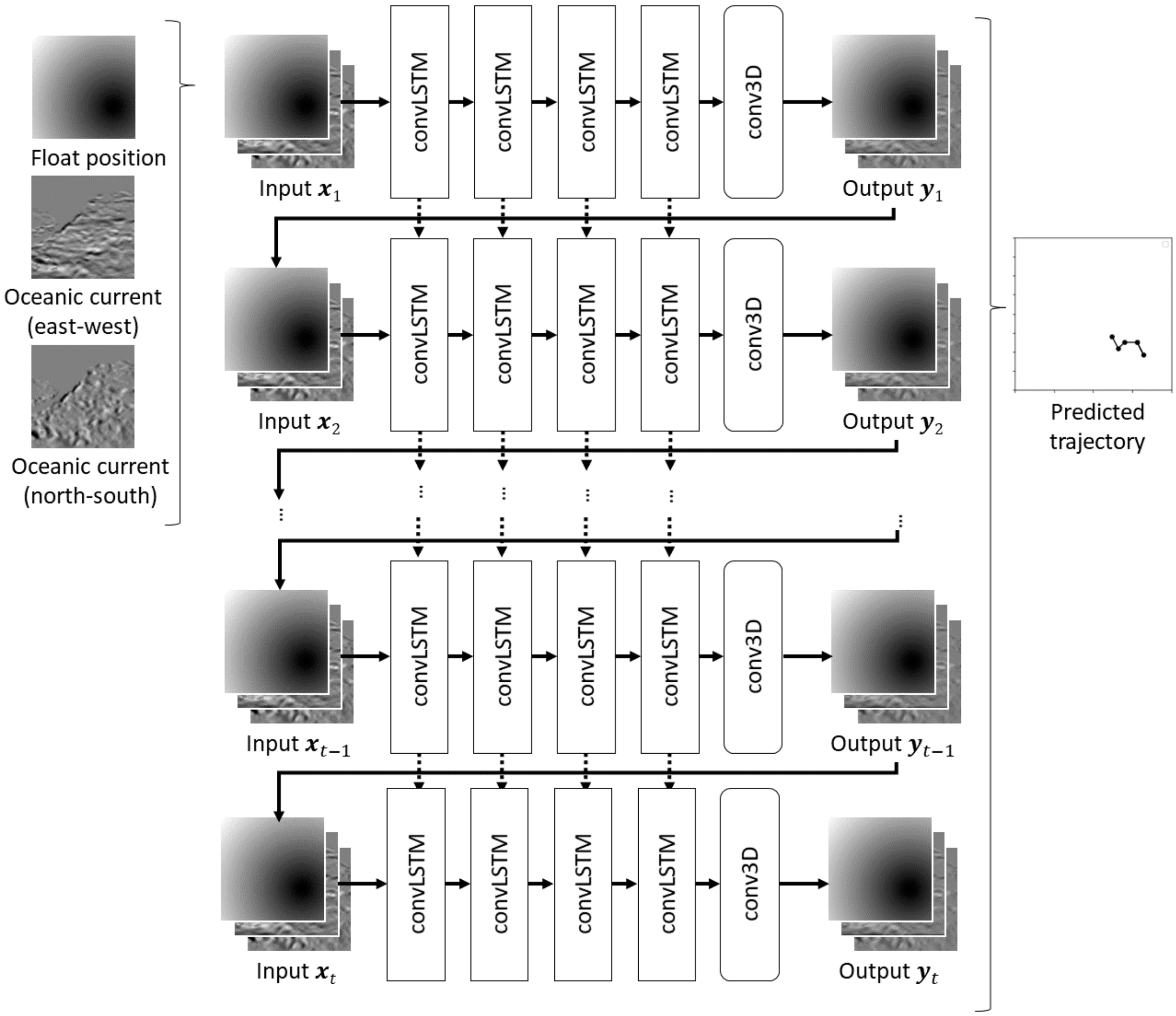
The ocean is recognized as a driving source of global warming and climate changes. This is because it occupies about 70% of the earth's surface and has a heat capacity more than 1000 times as much as of the atmosphere. The physical state observation inside the ocean is necessary to understand oceanic variability; however, it is difficult by research vessels to conduct long-term ocean monitoring. Therefore, the international Argo project has started since 2000 with the aim of long-term, real-time, and globally-covered ocean monitoring system.

In this program, more than 30 countries operate more than 3,800 Argo Floats, which are autonomous buoys and report observation data in real-time via satellites. A certain country manages each float, and it is necessary to obtain permission if there is a possibility of entering the economic zone of another country. Currently, numerical simulation is performed to predict float trajectory before deploying the float; however, the numerical simulation does not take into account the occurrence of vortices that may affect the movement of the float. Therefore, applications for permissions are being made to all possible countries of which the float may enter the economic zone.

Therefore, this study proposes a machine learning-based method for Argo float trajectory prediction, which allows reducing the number of countries that have to obtain permissions to enter the float. The proposed method adopts convolutional long short term memory (ConvLSTM), which is a recurrent neural network and also has the advantages of a convolutional neural network.

The advantages of the proposed methods are that it performs inductive learning based on past float trajectories, and allows adopting multiple observation data that have different properties such as float positions and ocean current data. The float data consists of the latitude and longitude position and the time when floating on the sea surface every ten days. The ocean current data is based on the monthly average flow velocity in each direction of east, west, north, and south in a range of 0.5 x 0.5 degrees square. To handle both data with different properties in a unified manner, all data is translated into a single image containing multiple channels. In addition, to unify the time resolution, images of ocean current are linearly interpolated.


Float position
Oceanic current (east-west)
Oceanic current (north-south)
Input $\boldsymbol{x}_1$
Input $\boldsymbol{x}_2$
Input $\boldsymbol{x}_{t-1}$
Input $\boldsymbol{x}_t$
convLSTM
conv3D
Output $\boldsymbol{y}_1$
Output $\boldsymbol{y}_2$
Output $\boldsymbol{y}_{t-1}$
Output $\boldsymbol{y}_t$
Predicted trajectory