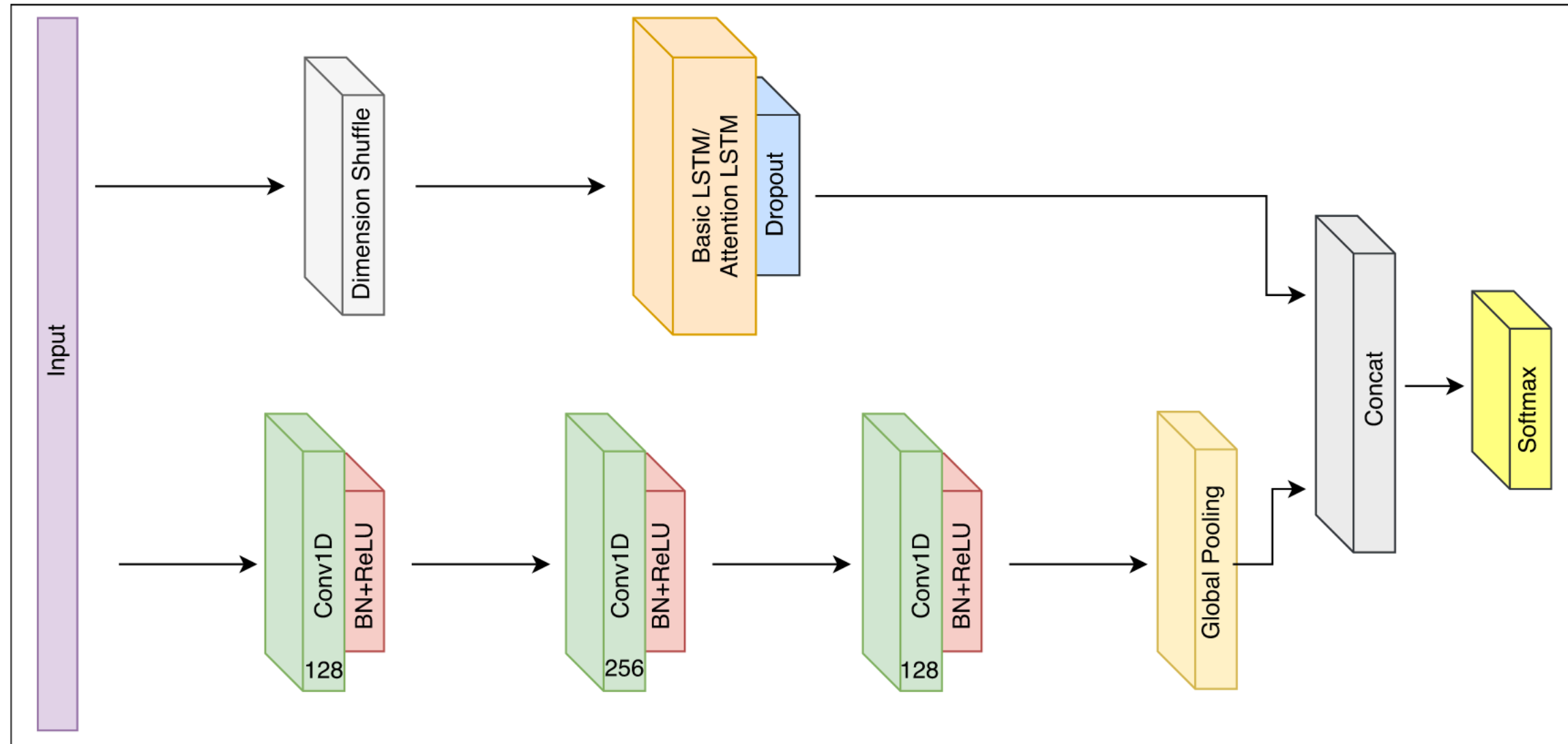
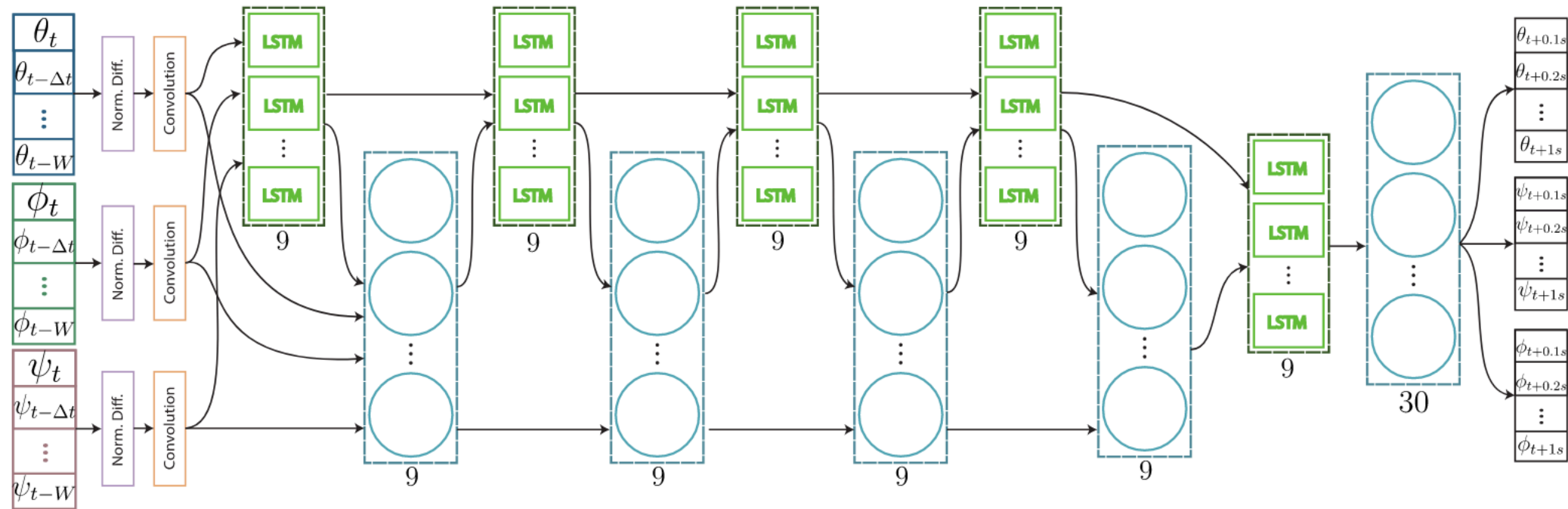


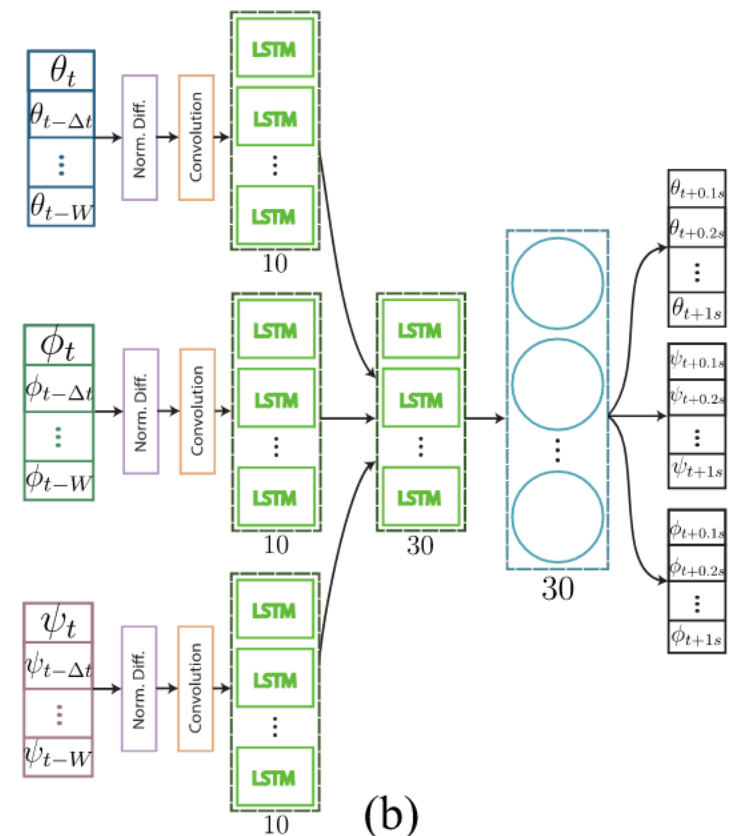
Fig. 1. The network structure of three tested neural networks. Dash line indicates the operation of dropout.



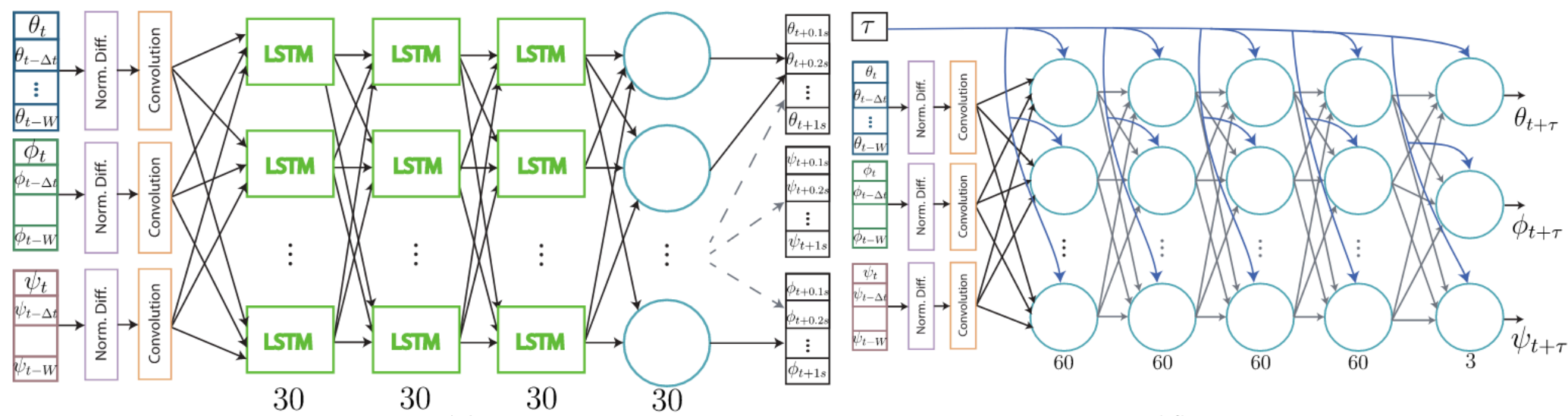
**FIGURE 1.** The LSTM-FCN architecture. LSTM cells can be replaced by Attention LSTM cells to construct the ALSTM-FCN architecture.



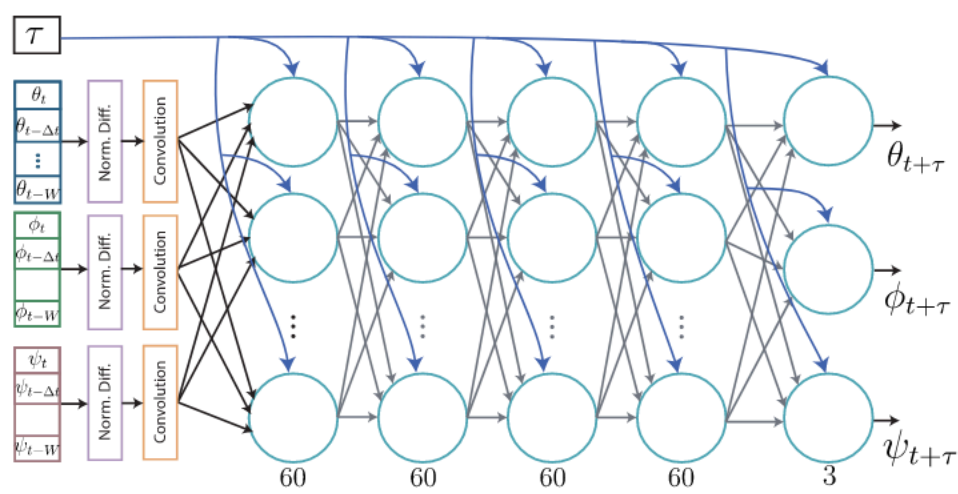
(a)



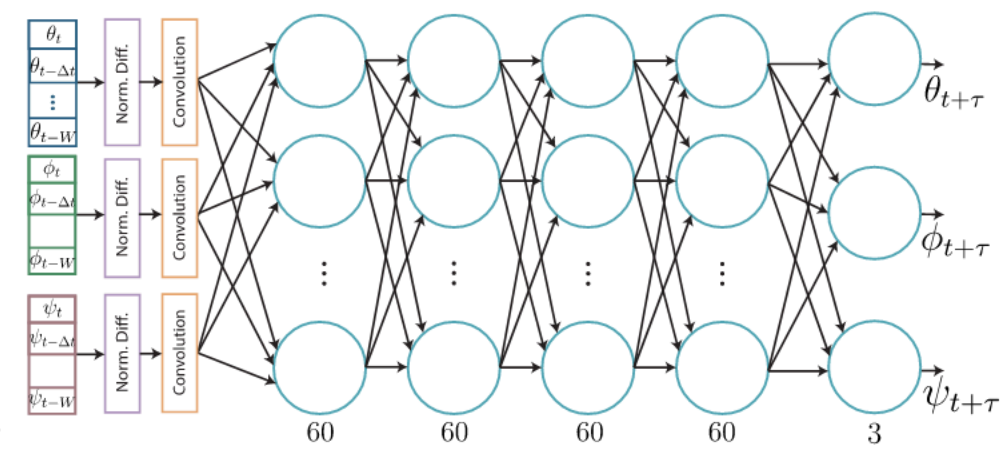
(b)



(c)



(d)



(e)

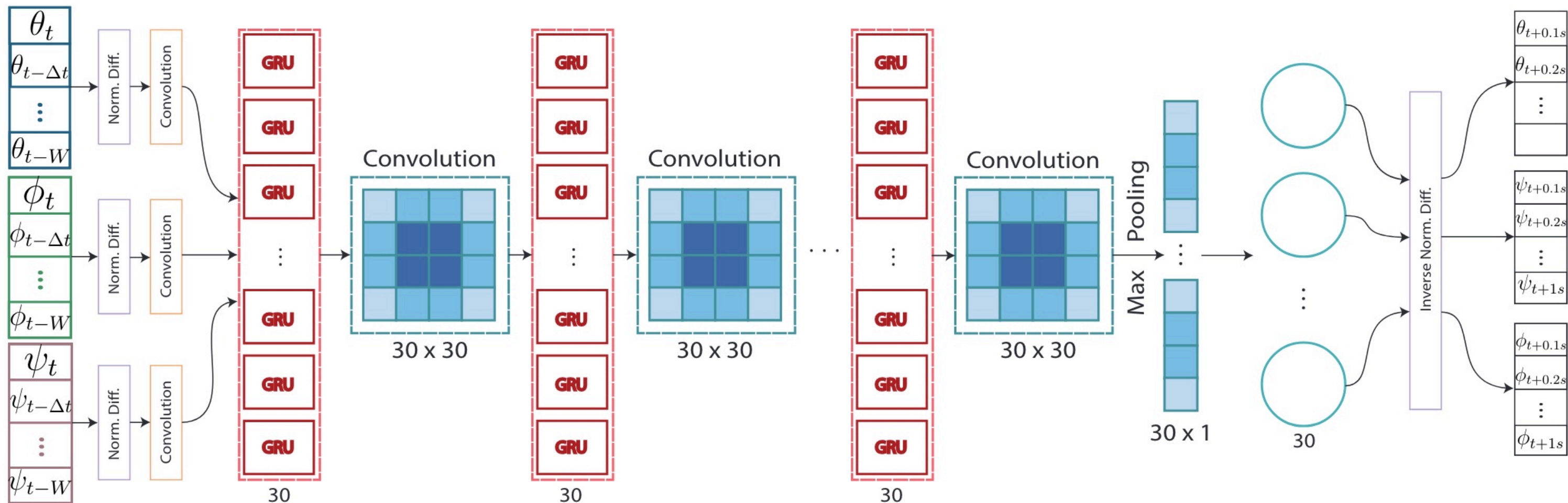


Fig. 9: Schematic overview of our proposed deep neural network for head-motion prediction. The input is first transformed to normalized difference to ensure generalization, and passed through a convolution unit that acts as a low-pass filter. Six sequential GRU and convolution units compute the most distinct features at different granularities. A subsequent max pooling layer downsamples the output of the last convolution layer and preserves the most significant features. After a dense feed-forward network, the differences are inverted to absolute values. The output predicts a whole sequence of future orientation values ( $\xi_{t+n \cdot 100\text{ms}}^{\text{pred}} \forall n \in \mathbb{Z}, n = 1, \dots, 10$ ).

### C. Acceleration Integration

The data collected by IMU includes acceleration and Euler angle. Generally speaking, displacement can be obtained by integrating acceleration twice. In addition to using model to predict displacement, We also tried to integrate the acceleration collected by IMU to get the velocity by Equation (2) where  $v_t$  is the velocity at time  $t$ ;  $a_t$  is the acceleration at time  $t$ . The integration result of velocity is in Fig. 3. We can see the x-axis has an increasing positive deviation as time goes by; y-axis and z-axis also have small deviations respectively. Next, we used Equation (3) where  $d_t$  is the displacement at time  $t$  to integrate the velocity and get the displacement. The displacement of the target, prediction and integration compared result is in Fig. 4. Green line is integration result, as for blue and orange line are the target and prediction result respectively. We can see that integration result is much worse than prediction result of model. We speculate that it should be related to the errors of IMU. When testing IMU, we found that it still has a slight acceleration even if IMU is static. These errors would be accumulated and cause a large deviation in displacement when integration acceleration twice.

$$v_t = v_{t-1} + a_t * t \quad (2)$$

$$d_t = v * t + \frac{1}{2} * a_t * t^2 \quad (3)$$