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MULTIMEDIA CONTENT PREDICTION USING THE KALMAN FILTER

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ABSTRACT

In this work, we explore a prediction method, based on the Kalman filter, for multimedia content delivery purposes. In summary, we predict the multimedia content based on their respective multimedia content identifier, such as by means unique identifiers in the network layer (using the DSCP field in an IP network, for example) or in the application layer (using application content tags, for example). A computational environment, simulating four multimedia services, is used to obtain experimental results. The obtained results show that the proposed method can be used to perform the multimedia content prediction based on their multimedia content identifiers. This approach is important to improve the multimedia content delivery and to increase the user-perceived Quality of Experience (QoE).

1 INTRODUCTION

Day after day, multimedia applications and services, such as 3D video or graphics and multimedia sharing services, among others, are becoming more and more popular, increasing the network traffic load and making the traffic profiles much more detailed and complex. In this scenario, the multimedia content delivery is challenging and a proper method to increase the distribution efficiency is nearly mandatory.

In order to contribute to this scenario, this work explores a prediction method for multimedia content delivery purposes. In summary, different from some prediction approaches (Kryfts et al. 2016), we predict the multimedia content based on their respective multimedia content identifier, such as by means unique identifiers in the network layer (using the DSCP field in an IP network, for example) or in the application layer (using application content tags, for example). For this, we use the Kalman filter (Kalman 1960) and the Kalman subfilter (Neto and Kuga 1982). This approach can be useful for many purposes, such as for QoS and routing mechanisms, and for content-based multimedia indexing and retrieval, among others.

2 PROPOSED PREDICTION METHOD, SIMULATION RESULTS AND CONCLUSION

In this work, we combine the Kalman filter and its subfilter to provide a prediction method for multimedia content delivery purposes. In this scenario, the predictor module is implemented by the Kalman filter and its subfilter. It is used to make the predictions of the multimedia content based on the observed multimedia content identifier. In turn, the purpose of the subfilter is to guarantee the filter's stability, i.e. to avoid filter divergence (Ursini et al. 2014). After applying the Kalman subfilter, the method executes the traditional Kalman filter algorithm. The schematic organization of the proposed approach is shown in Fig. 1.

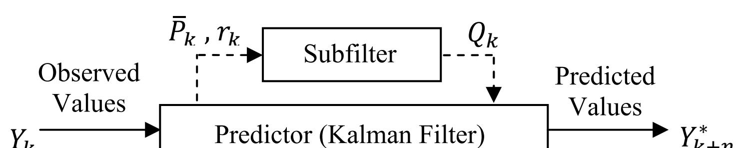

Fig. 1. Schematic organization of the proposed prediction method.

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In this case, Y_k corresponds to the observed (measured) multimedia content; $\bar{P}_k$ is the error covariance of the state estimate; r_k is the prediction error; Q_k is the covariance of the process noise; and, Y^*_{k+n} corresponds to the predicted (filtered) multimedia content.

In this context, in order to evaluate our prediction method, we implement a computational environment using the Wolfram Mathematica software (version 11). In this environment, we simulate four multimedia services, such as audio, voice, video and data services, to provide the multimedia content to be observed and predicted using the Kalman filter and its subfilter. We assign different identifiers to identify each multimedia service (and their respective multimedia content) in our computational environment. For preliminary evaluation purposes, we assign the values "1", "2", "3" and "4" for these identifiers. Then, we generate these identifiers randomly in our computational environment. Thus, the multimedia content of each multimedia service were observed and predicted based on their respective multimedia content identifier. Finally, to perform the prediction of the multimedia content in our computational environment, we implemented the proposed prediction method using the Kalman filter and its subfilter.

In this scenario, during the computational evaluation, the proposed method proved to be functional. The predicted multimedia content was consistent with the observed multimedia content. As an example, Fig. 2 shows a graph with the observed multimedia contents and with the predicted multimedia contents, both based on the identifier of each multimedia content simulated in our computational environment. In this example, the prediction of the multimedia contents was performed using 48 observed multimedia content identifiers, both randomly simulated in our computational environment.

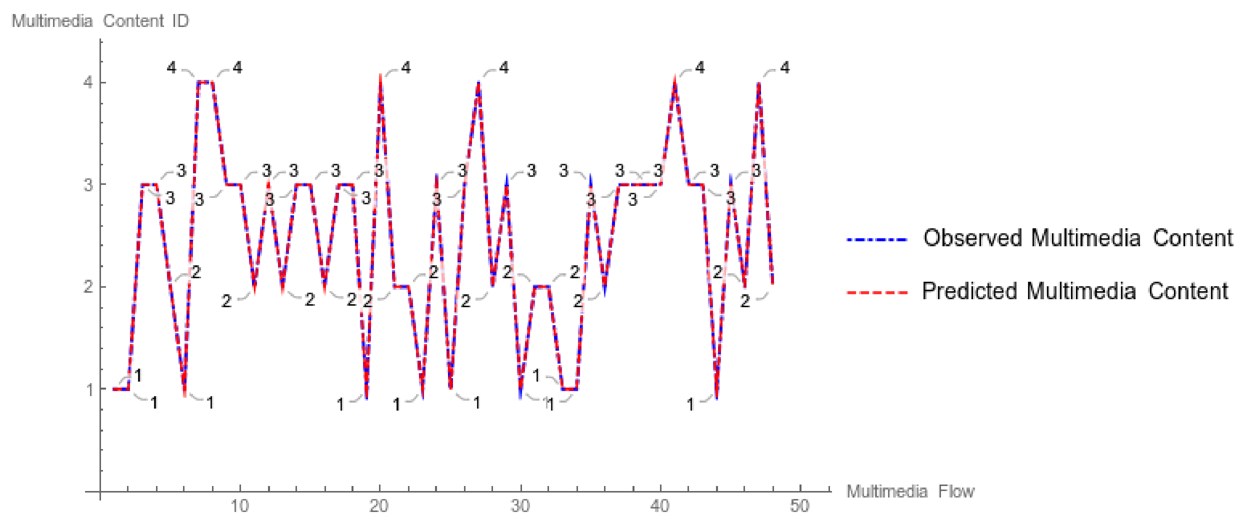

Fig. 2. Observed multimedia contents and predicted multimedia contents, both based on the identifier of each multimedia content simulated in our computational environment. In this example, the prediction of the multimedia contents was performed using 48 observed multimedia content identifiers.

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