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With best wishes R. Kalman

Kalman Filtering: Past and Present. An outlook from Russia. (On the occasion of the 80th birthday of Rudolf Emil Kalman)

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Abstract—This article is in honor of the 80th birthday of Rudolf Emil Kalman. A brief biography of R.E. Kalman is presented. The most important facts concerned with the creation of the celebrated Kalman filter are briefly outlined. Some trends in the development of applied methods for solution of filtering problems are analyzed. Kalman's relations and contacts with Russian scientists as well as their contribution to filtering theory and its applications are discussed.

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INTRODUCTION

In 2010 the scientific community celebrated the 80th birthday of Rudolf Emil Kalman, one of the creators of modern control and filtering theory. His contribution to this scientific field is generally recognized and widely covered in literature. As far back as 20 years ago, there appeared a book *Mathematical System Theory: The Influence of R.E. Kalman*. It was a festschrift in honor of Professor R.E. Kalman on the occasion of his 60th birthday [1]. It included articles of leading scientists, who described the impact of Kalman's work on different applications of control and filtering theory. Another remarkable book *Control Theory: Twenty-Five Seminal Papers (1932–1981)* edited by Tamer Basar was published in 2001 [2]. It was prepared on the initiative of the IEEE Control Systems Society with the aim to highlight the most significant results obtained in a pivotal period in the history of the development of control theory. The 12-member editorial board of this book consisted of distinguished scientists from different countries. Among the authors of the seminal papers included in this book were H. Nyquist, N. Wiener, L.S. Pontryagin, V.A. Yakubovich, and a number of other world-renowned scientists. It is worthy of note that Kalman was the only scientist to have three papers included in this publication. I would like to emphasize the fact that two of them were written by him at the age of 30 [3–5].

Kalman has visited Russia, where he is highly regarded for his accomplishments, on many occasions. He is acquainted with many Russian scientists. The most important of his articles and books were promptly translated into Russian; they are well known to Russian control theorists [6–10]. In April 2010, a seminar dedicated to the 80th Birthday of R.E. Kalman was held in Moscow by the Institute of Control Sciences of the Russian Academy of Sciences with the assistance of the Academy of Navigation and Motion Control[2], to pay a tribute to the outstanding scientist [11]. On June 2, 2010, the author of this paper made a presentation at the Regular General Meeting of the Academy of Navigation and Motion Control also devoted to the jubilee of Rudolf Emil Kalman. It dealt with two main issues. First, it touched briefly upon the background and consequences of one of Kalman's most important results – the discovery of the recursive optimal estimation procedure that is now known as the Kalman filter. The second subject was concerned with Kalman's relations and contacts with Russian scientists as well as their contribution to filtering theory and its applications.

This article is based upon the materials of the presentation made at the General Meeting of the Academy of Navigation and Motion Control.

BRIEF BIOGRAPHY

Rudolf Emil Kalman was born in Budapest, Hungary, on May 19, 1930. Along with his family, he immigrated to the United States during World War II [1, 12, 13]. He studied electrical engineering at the Massachusetts Institute of Technology (MIT) in Cambridge. Kalman received his bachelor's degree in 1953 and his master's degree in 1954. Later he studied under Professor John R. Ragazzini and in 1957 he received his doctorate degree from Columbia University. From 1955 to 1957 Kalman was employed as a staff engineer at the IBM Research Laboratory. Since 1958 he worked for the Research Institute for Advanced Studies in Baltimore (RIAS). The institute was headed by Solomon Lefschetz (1884–1972), a Russian-born

The text was submitted by the author in English.

[2] The International Public Association *Academy of Navigation and Motion Control* was founded in February 1995 as a public association of scientists and researchers in the field of navigation and motion control.