ABILITY FORECAST FOR A TRANSIT TRAFFIC SIGNAL SYSTEM

Journal of Advances in Science and Technology

Vol. VI, Issue No. XII, February-2014, ISSN 2230-9659

AN INTERNATIONALLY INDEXED PEER REVIEWED & REFEREED JOURNAL

Journal of Advances in Science and Technology
Vol. VI, Issue No. XII, February-2014, ISSN 2230-9659

Ability Forecast for a Transit Traffic Signal System

Ruchi Tyagi

Research Scholar CMJ University, Shillong, Meghalaya

Abstract – The paper has considered a traffic signal system for its ability forecast. This traffic signal system is based on three colour signals, namely red, green and yellow. The red colour signal is used to stop the traffic and the green colour signal is used to moving of stopped traffic. The yellow colour signal indicates ready to move and it works prior to green signal. Therefore, on failure of red or green colour signal the whole system goes to failed state while on failure of yellow colour signal the system works in reduced efficiency state.

Key Words : Traffic Signal System, Efficiency.

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INTRODUCTION

The whole system can also fail due to environmental reasons like storm, heavy raining etc. The system has to wait for repair in case of environmental failure otherwise; the repair facilities are always available. All the failures follow exponential time distribution whereas all repairs follow general time distribution. Pre-emptive resume policy has been adopted for repair purpose. Repair of red or green signals pre-empts the yellow colour signal.

Since, the system under consideration is of Non-Markovian nature, the supplementary variable technique has been used to mathematical formulation of system. State-transition diagram has shown in fig -1. Difference-differential equations for all the transition-states have been obtained. Laplace transform has been used to solve these mathematical equations. Availability and profit function of considered system have computed. Ergodic behaviour of the system and a particular case have been obtained to improve practical utility of the model.

FORMULATION OF MATHEMATICAL MODEL

Probability considerations and limiting procedure yield the following set of difference-differential equations governing the behaviour of considered signal system:

$$\left(\frac{d}{dt}+R+G+Y+e_1\right)P_0(t)=\int_0^\infty P_R(x,t)\mu_R(x)dx+\int_0^\infty P_G(y,t)\mu_G(y)dy$$

$$+\int_0^\infty P_Y(z,t)\mu_y(z)dz+\int_0^\infty P_{ER}(m,t)\mu_{ER}(m)dm \quad \textbf{...(1)}$$

$$\left[\frac{\partial}{\partial x}+\frac{\partial}{\partial t}+\mu_R(x)\right]P_R(x,t)=0 \quad \textbf{...(2)}$$

$$\left[\frac{\partial}{\partial y}+\frac{\partial}{\partial t}+\mu_G(y)\right]P_G(y,t)=0 \quad \textbf{...(3)}$$

$$\left[\frac{\partial}{\partial t}+W\right]P_{EW}(t)=e_1P_0(t)+e_2P_Y(t) \quad \textbf{...(4)}$$

$$\left[\frac{\partial}{\partial m}+\frac{\partial}{\partial t}+\mu_{ER}(m)\right]P_{ER}(m,t)=0 \quad \textbf{...(5)}$$

$$\left[\frac{\partial}{\partial z}+\frac{\partial}{\partial t}+R+G+e_2+\mu_Y(z)\right]P_Y(z,t)=\int_0^\infty P_{YR}(x,z,t)\mu_R(x)dx+\int_0^\infty P_{YG}(y,z,t)\mu_G(y)dy \quad \textbf{...(6)}$$

$$\left[\frac{\partial}{\partial x}+\frac{\partial}{\partial t}+\mu_R(x)\right]P_{YR}(x,z,t)=0 \quad \textbf{...(7)}$$

$$\left[\frac{\partial}{\partial y}+\frac{\partial}{\partial t}+\mu_G(y)\right]P_{YG}(y,z,t)=0 \quad \textbf{...(8)}$$

Boundary conditions are:

$$P_R(0,t)=R\ P_0(t) \quad \textbf{...(9)}$$

$$P_G(0,t)=G\ P_0(t) \quad \textbf{...(10)}$$

$$P_Y(0,t)=Y\ P_0(t) \quad \textbf{...(11)}$$

$$P_{YR}(0,z,t) = R\ P_Y(z,t) \quad ...(12)$$

$$P_{YG}(0,z,t) = G\ P_Y(z,t) \quad ...(13)$$

$$P_{ER}(0,t) = W\ P_{EW}(t) \quad ...(14)$$

Initial conditions are:

$$P_i(0) = \begin{cases} 1, i = 0 \\ 0, i \neq 0 \end{cases} \quad ...(15)$$

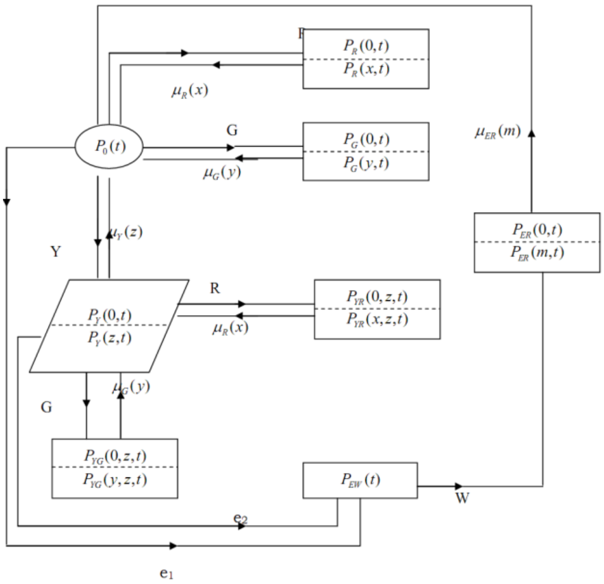

Fig-1 (State-Transition Diagram)

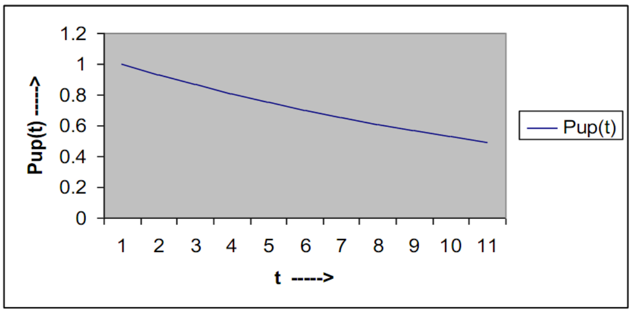

Fig-2

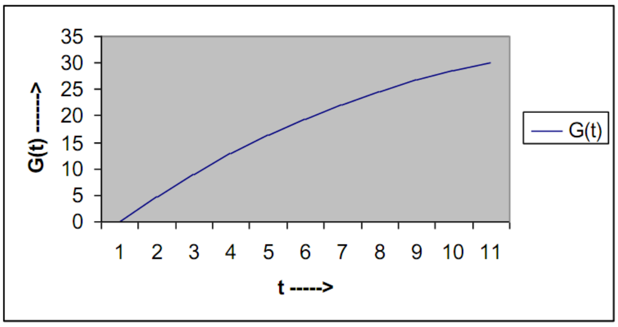

Fig-3

RESULTS AND DISCUSSION

In this study, the author deals with the transit traffic signal system for evaluation of its ability measures. Failures due to environmental reasons have also taken into account to obtain better results. Laplace transform of various transition state probabilities, shown in fig-1, have been obtained. Availability function and profit function for considered system have computed. Long run transition state probabilities and a particular case, when all repairs follow exponential time distribution, have been also determined to improve practical utility of the model. A numerical computation has mentioned to highlight important results of the study. By using this numerical computation. The corresponding graphs have been shown in fig-2 and 3, respectively. Fig-2 shows the way in which availability of system decreases as we increase in the value of time 't'. Fig-3 gives the variation in cost function with the time *t*.

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