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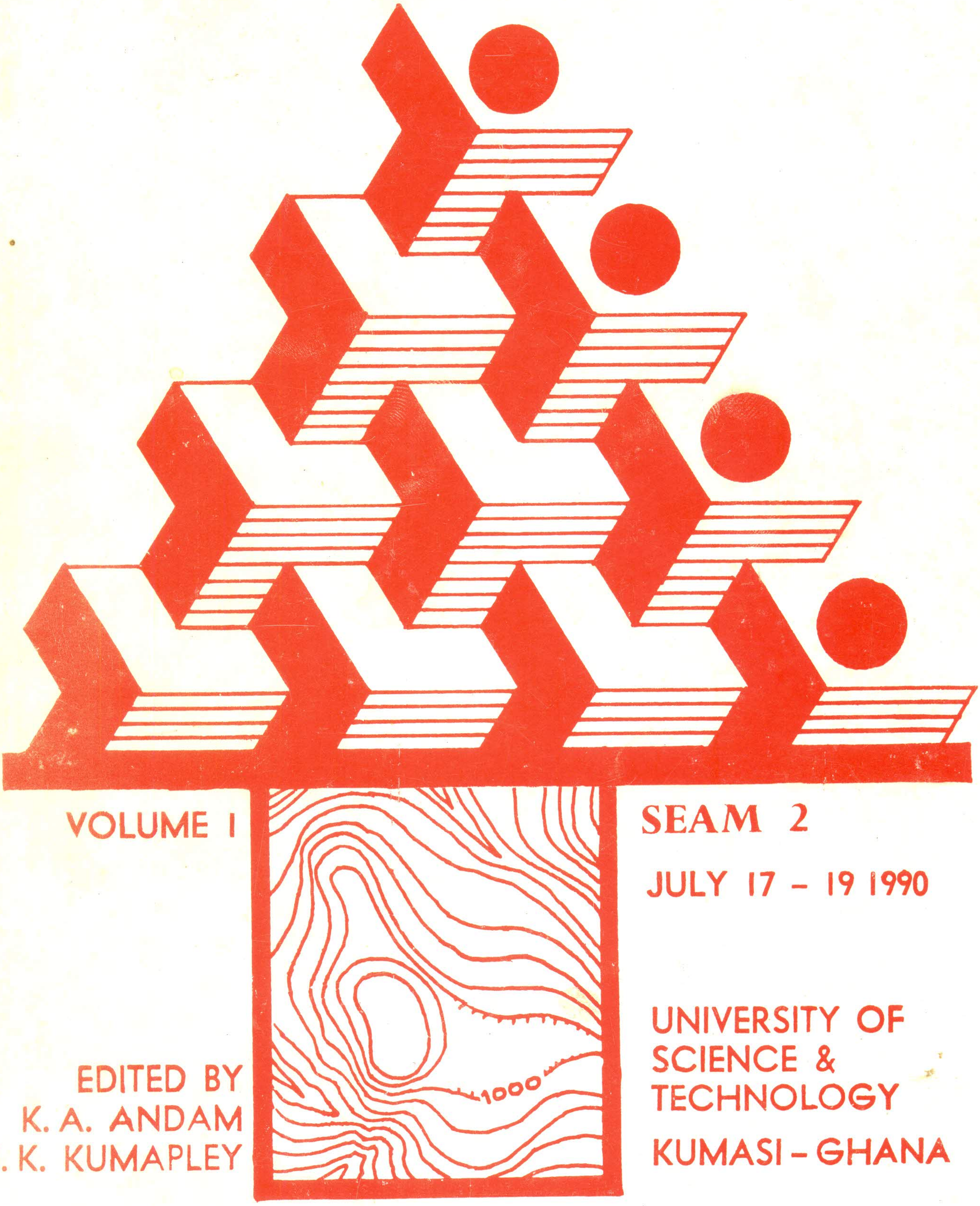

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ESTIMATE OF THE STRONG STABILITY OF A MODEL OF REFUSAL (FAILURE WITH OBSTRUCTION)

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ABSTRACT

Consider a queueing system $M_2/G_2/1$ with a relative priority, a distribution function of service time of the priority flux B_1 (respectively the non priority flux B_2) and the intensity of the non priority flux λ (resp. the priority $\lambda\theta$). If the parameter θ is small (that is the priority failures happen very seldom in the system), the subset of the system $M_2/G_2/1$ related to the priority failures can be looked upon as a small perturbation of the system $M/G/1$, with the parameter λ of the flux of arrivals and with a distribution function of the service time B_2. Let us denote $\pi_\theta(\cdot,\cdot)$ [resp. $\pi_o(\cdot,\cdot)$] the stationary joint distribution of the process for the number of demands of the first and secund priority for the system $M_2/G_2/1$ (resp. of the system $M/G/1$).

In this paper, we obtain an estimate for the deviation norm between π_θ and π_o. An exact computation of the constants which appear in this estimate is carried out.

RESUME

Considérons un système de files d'attente $M_2/G_2/1$ avec priorité relative de fonction de repartition de la durée de service du flot prioritaire B_1 (resp. non prioritaire B_2) et d'intensité du flot non prioritaire λ (resp. prioritaire $\lambda\theta$). Si le paramètre θ est petit (ie. que les pannes prioritaires se produisent rarement dans le système), la partie du système $M_2/G_2/1$ liée aux demandes prioritaires peut être interprétée comme une (petite) perturbation du système $M/G/1$, de paramètre du flot des arrivées λ et de fonction de repartition de la durée de service B_2. Notons par $\pi_\theta(\cdot,\cdot)$ [resp. $\pi_o(\cdot,\cdot)$] la distribution stationnaire conjointe du processus nombre de demandes de la première priorité et de la deuxième priorité

du système $M_2/G_2/1$ (resp. du système $M/G/1$).

L'objet de cette communication est d'obtenir l'estimation de la norme de déviation entre π_θ et π_0. Le calcul exact des constantes a été effectué.

1. INTRODUCTION

The purpose of this paper is to obtain the conditions and estimations of the strong stability of an imbedded Markov chain in an $M_2/G_2/1$ system with a relative priority.

The model shown in this work may be considered as a model of refusal, for which the repairing of the defective element can be delayed until the end of the service for the demand of the device. JAISWALL calls this type of failure: with obstruction [

In the computing systems for exemple, the happening of a default (some types of mechanical failures or errors in the logiciel) does not interrupt the compilatio of a program. It is only after that we proceed to eliminate the default.

The proof of the article's result is based on the operator's approach, whose concepts have been introduced in [1] and the qualitative analysis for an $M_2/G_2/1$ system realised in [2] . In comparaison to the others methods (metric method, method of the test function [8]), the opérator approach allows to find the exact asymptotic decompositions for the characteristics of the perturbated system.

We should finally indicate that in pratice, in the analysis of these systems, we never know exactly the distributions of the arrivals (we only estimate the degree of proximity relatively to the one given). That is why obtaining inequalities of this type will allow us to estimate numerically the uncertainty shown in this analysis (see [6]).

We can point out that this type of result can be used to ameliorate the effi- -ciency of the functionning of complex systems.

2. PRELIMINARIES AND STATEMENT OF THE PROBLEM

2.1 Consider a queueing system $M_2/G_2/1$ with a relative priority, a distri- -bution function of the service time of the priority flux B_1 and the non priori- -ty flux B_2. The size of the queue is infinite and the service discipline is FIFO (in each flux). Let us denote by λ the intensity of the non priority flux and by $\lambda\theta$ that of the priority flux.

Suppose that the parameter θ is small (that is the priority failures happen very seldom in the system). Let us denote X_n^i , i=1,2 ,the number of demands for the i^{th} priority at the time of the end service of the n^{th} demand.

The double sequence $X_n = (X_n^1 , X_n^2)$ constitutes a Markov chain with transition kernel

$$P_\theta = \left\| P_{kl}(i,j,\theta) \right\|_{i,j=o}^{\infty} \qquad \text{(see [4] or [1])}$$

At the same time, we consider a queueing system $M_2/G_2/1$ with a relative priority, when θ tends to zero, having the same distribution of the service time as the system considered previously.

To estimate the difference between the stationary distributions of the chain X_n in the $M_2/G_2/1$ and $M/G/1$ systems, we introduce in the space $\mathcal{M} = \{\mu(i,j)\}$ of finite measure on $N\text{x}N$, a family of norms

$$\|\mu\|_v = \sum_{i\geq o} \sum_{j\geq o} V(i,j).|\mu(i,j)| \tag{1}$$

where $V(i,j)$ is a finite function (not necessarely bounded) different from zero in $N\text{x}N$, and $|\mu|$ is the variation of the measure μ.

This norm induces a corresponding norm in the space of transition kernels on $(N\text{x}N , \mathcal{B}(N\text{x}N))$,

$$\|P\|_v = \sup_{k\geq o} \sup_{l\geq o} \frac{1}{V(k,l)} . \sum_{i\geq o} \sum_{j\geq o} V(i,j).P_{kl}(i,j)$$

All the notions and notations not defined here, can be found in [2]. In particular, the definitions of a strong stability in the sens this research goes, are given in the first paragraph (or in [1]), whereas the expressions of transition kernels P_θ and $P_o = \left\| P_{kl}(i,j,o) \right\|_{i;j=o}^{\infty}$.

Recall that we associate with each transition kernel P_{kl} the linear mapping $P_{kl} : \mathcal{M} \longrightarrow \mathcal{M}$ (see [1]). Let η be the space of bounded measurable functions in $N\text{x}N$. The symbol $P.f$, for $f \in \eta$, will designate the function

$$(P.f)(k,l) = \sum_{i\geq o} \sum_{j\geq o} f(i,j).P_{kl}(i,j) \tag{2}$$

Furthermore, every integral with unspecified domain of integration is taken all over $\mathbb{R}^+$.

2.2 Let us denote $\beta_o = \sup(\beta : \hat{f}_2(\lambda\beta - \lambda) < \beta)$, where

$$\hat{f}_i(s) = E\exp(s\,\xi_i) = \int \exp(su).dB_i(u) \,, \quad i=1,2 \tag{3}$$

and introduce the following condition of geometric ergodicity

$$\text{a) } \lambda E\xi_2 < 1 \quad ,\text{b) } \exists \; a>0 : E\exp(a\xi_2) = \int \exp(au).dB_2(u) < \infty \tag{4}$$

In [2] ,we proved that if the condition is verified,then for all β such that $1<\beta<\beta_0$,the imbedded Markov chain $X_n = (X_n^1 , X_n^2)$ is strongly v-stable for a function $V(n,m) = \alpha^n.\beta^m$,

$$\text{where} \quad \alpha = \hat{f}_1(\lambda\beta - \lambda)/\rho \quad \text{and} \quad \rho = \hat{f}_2(\lambda\beta - \lambda)/\beta < 1 \tag{5}$$

In [3] ,we proved that for all β such that $1<\beta<\beta_0$, for all α such that $\alpha > 1$ and for all θ such that $0 \leq \theta \leq \beta - 1$, $0 \leq \theta \leq \alpha - 1$, we have the inequality

$$\| P_\theta - P_0 \|_v \leq \theta . D , \tag{6}$$

where

$$D = \left\{ \lambda\hat{f}(\lambda\beta - \lambda) + \alpha\lambda \hat{f}'(a) + \hat{f}(a) \right\} \tag{7}$$

$$a = \lambda\beta + \alpha\lambda\theta - \lambda\theta - \lambda ,$$

and

$$\hat{f}(a) = \hat{f}_1(a) + \hat{f}_2(a) .$$

These intermediate results allow us to consider the problem of obtaining estimations of stability,with an exact computation of the constants.For this, we will introduce:

$\{\pi_\theta(i,j)\}$ -the joint stationary distribution of the process of number of demands of the first priority and the secund priority of the system $M_2/G_2/1$.

$\{\pi_0(i,j)\}$ -the same distributions for the system $M/G/1$ with exponential distribution E of the flux of non priority arrivals and with distribution B_2 of the service time.

3. GENERATING FUNCTION

Let us note by $\Pi(Z_1 , Z_2)$ the generating function of the sequence $\pi(i,j,0)$, $i,j \geq 0$.

LEMMA

For $|Z_1| < 1$, $|Z_2| < 1$,we have the equality

$$\Pi(Z_1 , Z_2) = \frac{(Z_2 - 1).\hat{f}_2(\lambda Z_2 - \lambda)}{Z_2 - \hat{f}_2(\lambda Z_2 - \lambda)} . (1 - \lambda\mu) \tag{8}$$

where $\hat{f}_2(\lambda Z_2 - \lambda)$ is defined in (3) and $\mu = E\xi_2$.

PROOF

$$\Pi(Z_1, Z_2) = \sum_{i\geq o} Z_1^i \,\Pi\!\!\Pi(i, Z_2), \quad \text{where}$$

$$\Pi\!\!\Pi(i, Z_2) = \sum_{j\geq o} Z_2^j \,\pi(i,j,o)$$

From the expression of the transition kernel, it is easy to see that,

$$\pi(i,j,o) = 1_{i=o}\, \pi(o,o) C_j^2 + 1_{i=o} \sum_{n=o}^{j} \pi(o,j-n+1) C_n^2 + $$

$$+ 1_{j>o} \sum_{k>o} \left\{ 1_{i=k-1} \sum_{n=o}^{j-1} \pi(k,j-n) C_n^1 \right\},$$

where $C_j^i = \int dB_i(u).\exp(-\lambda u).\frac{(\lambda u)^j}{j!} \qquad i = 1,2$

a) <u>for $i=o$</u>,

$$\pi(o,j,o) = \pi(o,o) C_j^2 + \sum_{j+1\geq l>o} \pi(o,l) C_{j-l+1}^2 + \sum_{l=o}^{j} \pi(1,l) C_{j-l}^1$$

The resolution of this system uses the method of generating functions [6].

we obtain,

$$\Pi\!\!\Pi(1,Z_2) = \frac{Z_2 - \hat{f}_2(\lambda Z_2 - \lambda)}{Z_2.\hat{f}_1(\lambda Z_2 - \lambda)} . \Pi\!\!\Pi(o,Z_2) + \frac{(1 - Z_2).\hat{f}_2(\lambda Z_2 - \lambda)}{Z_2.\hat{f}_1(\lambda Z_2 - \lambda)} . \pi(o,o) \quad (9)$$

b) <u>for $i > o$</u>,

$$\pi(i,j,o) = \sum_{l=1}^{j} \pi(k,l) C_{j-l}^1 = \sum_{l=1}^{j} \pi(i+1,l) C_{j-l}^1$$

Also, it is easy to see that

$$\Pi\!\!\Pi(i,Z_2) = \sum_{l>o} \pi(i+1,l) Z_2^l . \hat{f}_1(\lambda Z_2 - \lambda) = \frac{\Pi\!\!\Pi(1, Z_2)}{\hat{f}_1^{i-1}(\lambda Z_2 - \lambda)} \quad (10)$$

c) When the demands of the priority flux are not in the system (ie. when $\theta = o$) we are in the case of the system M/G/1.

From [5],

$$\Pi\!\!\Pi(o,Z_2) = \frac{(Z_2 - 1).\hat{f}_2(\lambda Z_2 - \lambda)}{Z_2 - \hat{f}_2(\lambda Z_2 - \lambda)} . \pi(o,o) \quad (11)$$

This is the Pollatchek-Khintchin formula.

Furthermore, it is easy to see that $\pi(o,o) = 1 - \lambda\mu$ where $\mu = E\xi_2$ (12)

From here and from (9),(10) and (11),The lemma is proved. ■

4. ESTIMATE OF THE STABILITY

In order to use the corrollary 2 of theorem 3 [7] ,let'us estimate $\|\pi\|_v$ and $\|1\|_v$,where $1 \in \eta$ is the function identically equal to unity.

a) From (1),

$$\|\pi\|_v = \sum_{i \geq 0} \sum_{j \geq 0} V(i,j) \; |\pi(i,j,0)| ,$$

where $V(i,j) = \alpha^i . \beta^j$.

From (11) and (12),it is implied that,

$$\|\pi\|_v = \frac{(\beta - 1).\hat{f}_2(\lambda\beta - \lambda)}{\beta - \hat{f}_2(\lambda\beta - \lambda)} . (1 - \lambda\mu) \leq W$$

where
$$W = (\beta - 1)(1 - \lambda\mu) . \frac{\rho}{1 - \rho} \tag{13}$$

b) From the définition of $\| . \|_v$ in η (see [1]),and in considération of the inequality $\alpha^k . \beta^l > 1$,we obtain

$$\|1\|_v = \sup_{k,l} \frac{1}{\alpha^k . \beta^l} \leq 1 \tag{14}$$

THEOREM

Let us suppose that in the system $M_2/G_2/1$ with a relative priority,the ergodicity condition (4) is verified.

Then,for all β such that $1 < \beta < \beta_0$, $1 < \alpha$ and for all θ such that

$$0 \leq \theta < \min\left\{ \alpha - 1 \; , \; \beta - 1 \; , \; \frac{1 - \rho}{D(1 + W)} \right\}$$

we have the estimation,

$$\|\pi_\theta(.,.) - \pi_0(.,.)\|_v = \sum_{i,j} \alpha^i . \beta^j |\pi_\theta(i,j) - \pi_0(i,j)|$$
$$\leq \theta . W_\theta \tag{15}$$

where $W_\theta = D(1 + W).W.(1 - \rho - (1 + W)\theta D)^{-1}$,

ρ ,D, μ ,W and the generating function have been defined in (5),(7),(8) and (13

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LIVE LOAD STUDIES IN GHANA : A REVIEW

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ABSTRACT

The paper reports on the results of live load surveys that have been conducted in Ghana since 1981. A summary of important results is given for an average room use in office, domestic, institutional, hotel, church and assembly buildings. The results show remarkable differentials in the magnitude of live loads that were measured in these surveys and those surveys previously conducted in the world's industrialised countries.

RESUME

Ce travail relate les résultats d'un examen de charges mobiles, examen qui a été fait au Ghana depuis 1981. Un résume de ces résultats importants est donné à l'égard de l'uthilisation d'une salle/ chambre moyenne, soit au bureau, à domicile, à l'hotel, à une institution, à l'eglise ou aux bâtiments des assmblees. Ces résultats témoignent des différentiels remarquables dans la magnitude des charges mobiles qui ont été mesurées au cours de ces examens et des examens faits prealablement dans le monde des pays industrialises.

INTRODUCTION

The structural engineer requires the characteristics of live loads that are likely to be encountered on a structure during its lifetime before that structure could be designed. Recommended values of live loads are usually contained in codes of practice of the world's industrialised countries. Such design loads were computed from previous live load surveys. Generally all these live load data have come from live load surveys conducted in the industrialised countries of the world. Such data are not available for structural engineers of the developing world. Thus the trend has been to adopt the codes of practice of the industrialised world. This practice has two undesirable effects [1]: either the structure is designed to withstand too high a live load resulting in wastage or the structure is designed to withstand a low value of live load in which case the structure is unsafe.

Live loads have two components namely sustained loads and extraordinary or transient loads. The sustained load component comprises all furniture and normal personnel loads and the extraordinary load component comprises all transient crowding of load cells that take

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