Vol. 5, No. 3 March 2014 ISSN 2079-8407
Journal of Emerging Trends in Computing and Information Sciences

http://www.cisjournal.org

Application of Banach Space Ideal Properties in Image Transmission over Wireless Network

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ABSTRACT

The Banach space operator ideals and nuclear maps have a large class of morphisms which behave as if they were part of a compact closed category, that is, they allow one to transfer variables between the domain and the codomain. We use the concept of nuclearity in functional analysis to establish application aspect of Banach space ideal properties in the transmission of image over wireless network based on the embedded system**.**

Keywords: *A compact closed category, wireless network, embedded system.*

1. INTRODUCTION

This paper develops the concept of nuclearityin functional analysis, see for example [8], and the usual notion of binary relations with an eye towards certain applications in computer science.

Relations form a basic and ubiquitous mathematical structure. There has been much activity in formulating what relations are “abstractly”, so that one can generalize the concept to new situations. Typical examples of such formulations are the concept of Cartesian bicategories [1] and allegories [3]. One of the key aspects of the category Rel is the fact that one has ``transfer of variables" i.e. one can use the closed structure and the involution to move variables from ``input" to ``output". Intuitively speaking, this reflects the idea that the source and target of a binary relation are a matter of convention and a binary relation is an inherently symmetric object.

In many situations that otherwise resemble relations, one finds that the closed structure does not exist and hence one loses the ability to transfer variables. We demonstrate that through the concept of ideals and nuclearity in functional analysis[5] and the usual notion of binary, wireless infrastructure network based on the embedded system is a typical analogue of binary relations.

According to [7], a network is defined as a set of devices often referred to as nodes, connected by media links. A node can be a computer, printer or any other device capable of sending or receiving data generated by other nodes on the network. Wireless networks are generally created without the use of wires although made with the help of radio frequencies in air to transmit and receive data. An infrastructure network consists of a network with fixed and wired gateways. A mobile host communicates with a bridge in the network (called base station) within its communication radius. The mobile unit can move geographically while it is communicating. When it goes out of range of one base station it connects with the new base station and starts communicating through it. This is called handoff. In this approach the base stations are fixed. Figures 1 and2 illustrates set ups for wireless network and infrastructure network respectively,[7].

Fig 1: Wireless network

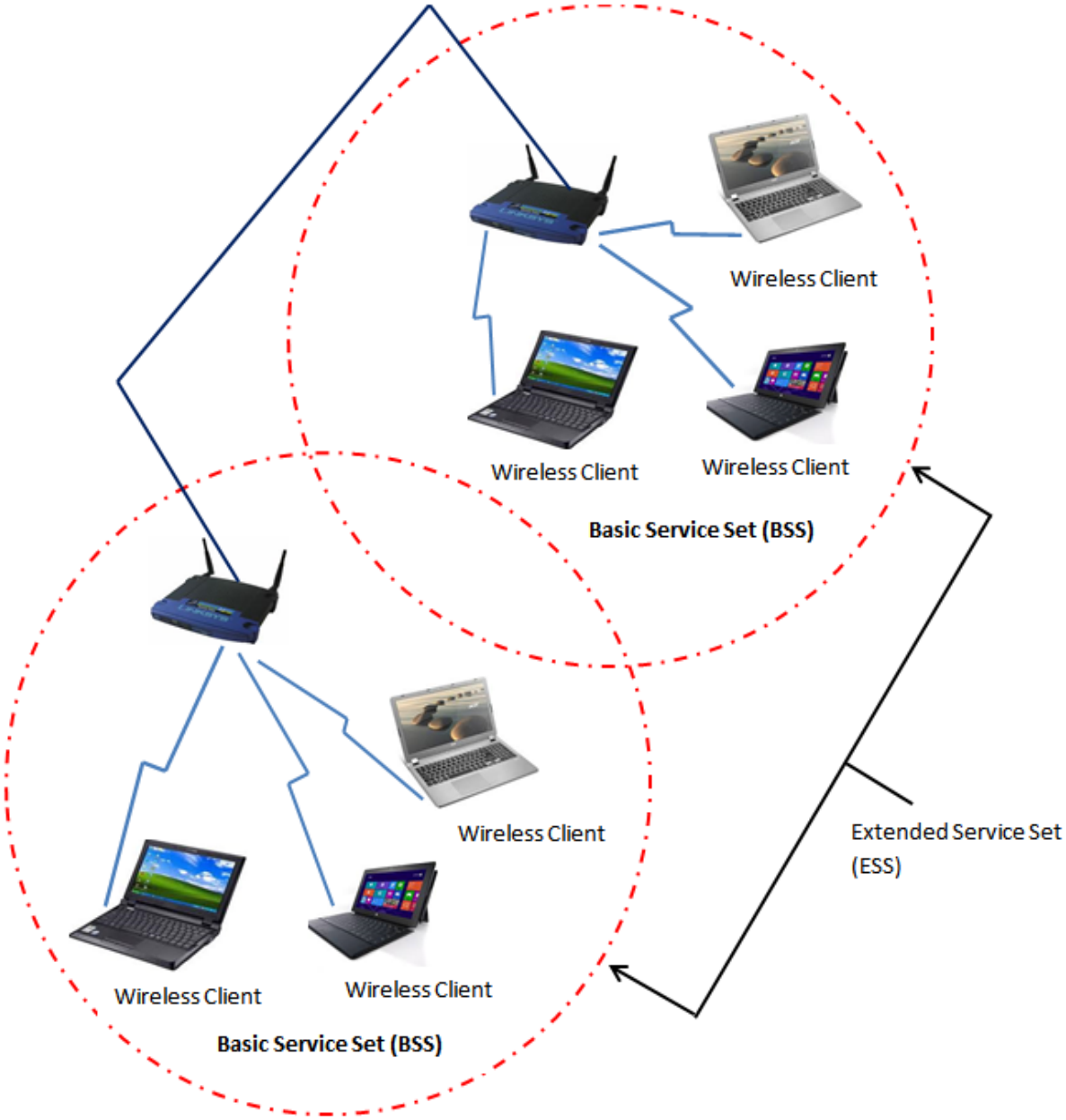

Fig 2: Infrastructure network

In the case of the transmission of image over wireless network based on the embedded system, [6] elaborates that the image is compressed on the S3C2440A processor which belongs to ARM9 family, then the compressed image is transmitted to a PC or Laptop. This transmission of image from server to client is done through Wi-Fi connection. The throughput of ARM processor is calculated after the image transmission. Here, image is as an input given from standard database. Compression of image uses RLE algorithm which is lossless. This compressed image given as an input to S3C2440A processor is transmits to the PC or Laptop as output. The figure below shows the connection and data flow within the Embedded System as illustrated by [6].

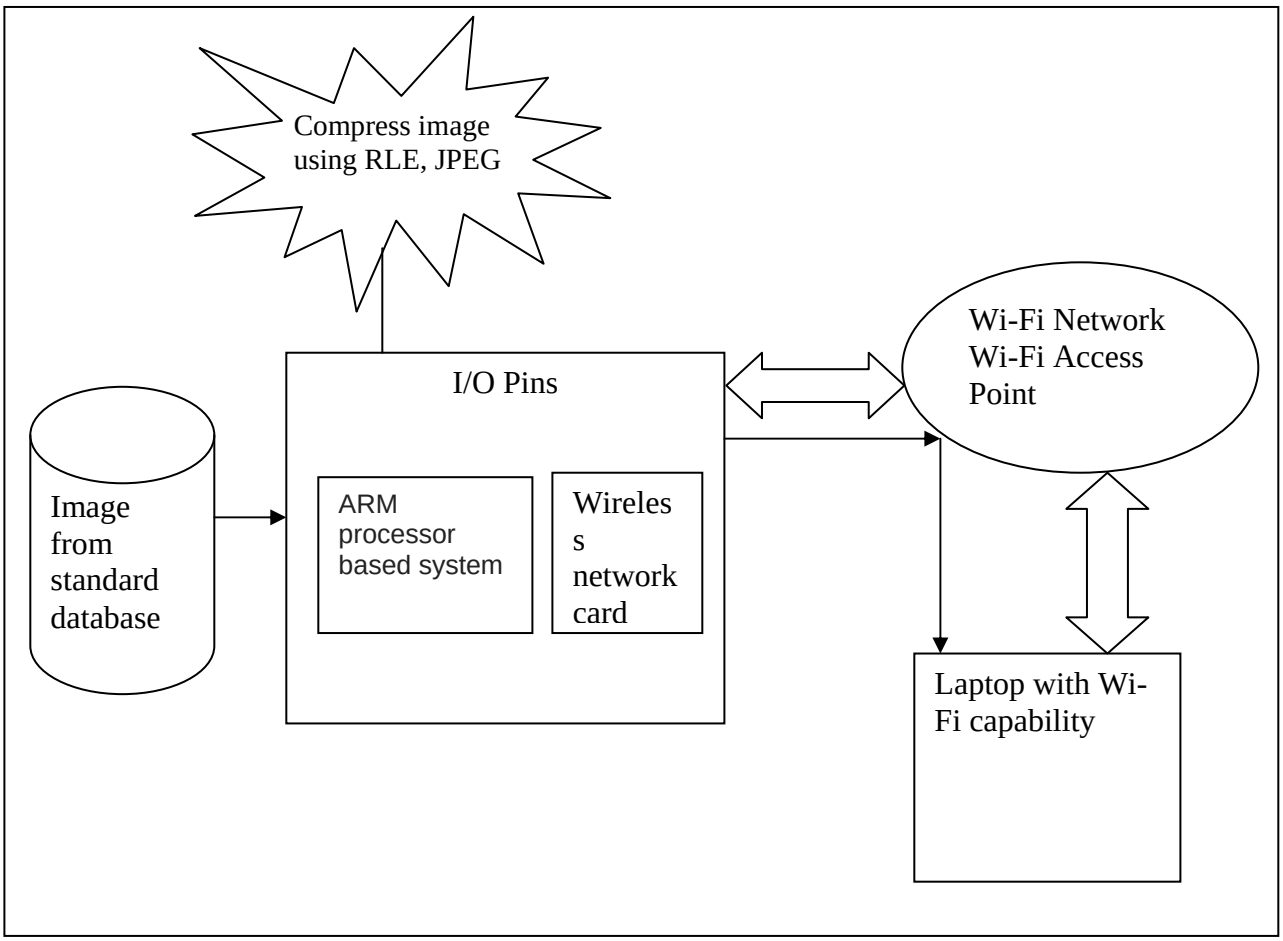

Fig 3: Wireless Transmission based on Embedded System

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2. APPLICATION ASPECT OF BANACH SPACE IDEAL PROPERTIES IN THE TRANSMISSION OF IMAGE OVER WIRELESS NETWORK

We recall in [5], the following assumptions by[4] for a vector space H being a nuclear space.

Consider a real complex topological vector space Hequipped with the following structure:- There is a sequence of inner-products $\langle .,. \rangle_p$, for $p \in \{0,1,2,3,\ldots\}$ on $\mathcal{H}$such that

$$\|.\|_0 \leq \|.\|_1 \leq \ldots\ldots\ldots\ldots (2.1)$$

DenoteH_0, the completion of $\mathcal{H}$in the norm $\|.\|_0$ and inside this Hilbert space the completion of $\mathcal{H}$with respect to $\|.\|_p$be a dense subspace denoted H_p. We assume that $H_0$is separable, and that$\mathcal{H}$is the intersection of all the spacesH_p.

Thus,

$$\mathcal{H} = \bigcap_{p=0}^{\infty} H_p \subseteq \cdots \subseteq H_2 \subseteq H_1 \subseteq H_0 \ldots\ldots\ldots\ldots (2.2)$$

Furthermore, we assume that each inclusion$H_{p+1} \to H_p$is a Hilbert Schmidt operator, i.e. there is an orthonormal basis $v_1, v_2, v_3, \ldots$in H_{p+1}forwhich

$$\sum_{n=1}^{\infty} \| v_n \|_p^2 < \infty \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2.3)$$

The topology on $\mathcal{H}$is the projective limit topology from the inclusions$\mathcal{H} \to H_p$, i.e. it is induced by the norms $\|.\|_p$. Thus an open set in this topology is the union of$\|.\|_p$-balls with $p$running over$\{0,1,2,3,\ldots\}$All these assumptions make $\mathcal{H}$ a nuclear space.

In [5],it was shown that the property of an ideal can be illustrated as according to the concepts of Hahn-Banach extension operator and tensor product spaces in relation to the nuclear space structure through topological vector spaces. Consequently, an extended version of the result of Proposition 2.1 about a locally convex space X being an ideal in a Banach space Y whenever $K(Z,Y)$ is an ideal in $K(Z,Y)$ for some convex, balanced 0- neighborhood space Z was obtained by [5].

Using essential properties in the proofs of Propositions 2.1 and 2.3 by [5], we illustrate that the concept of nuclearity in functional analysis for Banach space ideal properties is somewhat analogous to the principle of transmission of compressed image over wireless network on an embedded system.

Now, [6] defines an embedded system as a processor-based entity which has no or limited facilities for reprogramming from the outside. This is identical to the spacesX, Y, Z and W being locally convex for $X \otimes Z$to be an ideal in $Y \otimes W$, whenever $X$is an ideal in $Y$and Zbe an ideal in$W$([5], Proposition 2.1).The embedded system adopts ARM9 processor S3C2440A and Linux operating system which is standard processor devices combined with memory devices and application specific ICs on a single board. It is these devices that compress the image which is eventually transmitted to the PC or Laptop. Similarly, we note that in ([5], Proposition 2.1), for X an ideal in Y and Z an ideal in W, implies that there exists 0-neighbourhoods U and V in X and Z respectively such that the mappings $\psi(U)$ and $\phi(V)$ have compact closures in Y and W, of which both $\psi(U) \cdot X \to Y$ and $\phi(V) \cdot Z \to W$ are nuclear maps. This is essentially the working principle of the image compression on the S3C2440A processor. For example, the existence of 0-neighbourhoods U and V in X and Z respectively such that the mappings $\psi(U)$ and $\phi(V)$ have compact closures in Y and W is equivalent to the SAMSUNG's S3C2440A processor as the kernel of this system.

In the last step of the proof for Proposition 2.1 in [5], the illustration that since $\psi^* x = x, x \in X$, and$\phi^* z = z, z \in Z$, the map $\Phi : I(X,Z^*) \to I(Y,W^*)$which can be expressed as a composition of a nuclear map with a continuous linear map T defined by $\Phi(T) = \psi \circ Q \circ T^{**} \circ \phi^* \setminus Y$ being nuclear is the analogy of the overall transmission of image from server to client through Wi-Fi connection.

Due to growing tendency towards the integration of processor cores, memory and application specific, extensions on a single integrated circuit, usually called system-on-a-chip (SOC) is achieved in image transmission over wireless network by use of protocols. For instance, the TCP protocol gives acknowledgement to each request, hence a more reliable communication. Equivalently, more evident results of Proposition 2.1 were obtained in Proposition 2.4 by considering convex balanced 0-neighbourhoods instead of 0- neighbourhoods. Thus we claim that the use of protocols for improved image transmission over wireless network is precisely identical to the use of convex balanced 0- neighbourhoods instead of 0-neighbourhoods in showing that a locally convex space$X$ is an ideal in a Banach space$Y$, whenever the space$K(Z,X)$is an ideal in $K(Z,Y)$for some convex balanced 0-neighbourhood$Z$.

However, image compression method in this system poses some obstacles in the transmission of the image. [6] highlights two main ones as:-increasing of bit dependency which in turn introduces error extension effects and its extremely hostile and random nature of the channels that introduces distortion and considerably degrading the image quality. In [6], it is remedied that the use of Error control coding and addition of check bits successfully reduces these challenges. This attempt of elimination of the two major concerns is a complementation to the assertion by [5], that the property of X being an ideal in Y if and only if K(Z,X) is an ideal in K(Z,Y) is separable determined. ([5], Theorem 2.5), affirms that $K(Y,X)$is an ideal in $K(Y,Z)$if

and only if $K(W,X)$ is an ideal in $K(W,Z)$ for every separable ideal W in Y. This is because the separable ideal W is assumed to have a nuclear structure and for some sequence of inner products $\langle .,. \rangle_p$ for $p \in (0,1,2,3,\ldots)$ on $K(Y,Z)$ is such that

$\|.\|_p \leq \|.\|_1 \leq \infty$ and $K(Y,X)$ is a subspace in the completion of $K(Y,Z)$. Similarly, a composite nuclear map Ψ from $K(W,X)^* \rightarrow K(W,Z)^*$ which is a norm 1 decreasing projection can be defined on W^*. Hence Ψ is a Hahn-Banach extension operator equivalent to the continuous identity map in inclusion closed compact spaces $K(W,X)$ of $K(W,Z)$.

3. CONCLUSION

In this paper, it has been depicted that image transmission over this type of wireless network is done without the connection through any kind of cable and its working principle is analogous to the concept of nuclearity in functional analysis for Banach space ideal properties. This setup has benefits such as capabilities of allowing users to move their laptops from place to place within their work area without the need for wires and without losing network connectivity, less wiring that provides greater flexibility, reliability, increased efficiency and reduced wiring costs in communication. However, according to [2],there are risks that are inherent in any wireless communication network. The most significant risks typically associated with wireless communication being the technologies underlying communication medium, the air wave is open to attackers, hackers, which results to loss of confidentiality and integrity and the threat of denial of service (DOS) attacks. As an important area of future research, efforts can be geared towards the application of Banach space ideal properties in measures of gapping these wireless communication risks which includes accountability, piracy and security measures in wireless network.

ACKNOWLEDGEMENT

This project was funded by Chuka University IRF. Authors are grateful to the university management for the support accorded.

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