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**THÈME GÉNÉRAL :**

RECHERCHE SCIENTIFIQUE ET INNOVATIONS TECHNOLOGIQUES POUR LE DÉVELOPPEMENT  
DU SECTEUR PRIVÉ : QUELLE INTERFACE POUR QUELLES APPLICATIONS DES RESULTATS ?



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ACTES DU COLLOQUE

**JS-ISRADD 2021**

**JOURNÉES SCIENTIFIQUES INTERNATIONALES  
DE L'INSTITUT SCIENTIFIQUE DE RECHERCHE  
APPLIQUÉE POUR LE DÉVELOPPEMENT DURABLE**

Thème général :

Recherche scientifique et innovations technologiques  
pour le développement du secteur privé : quelle interface  
pour quelles applications des résultats ?

# Actes du colloque

*Amphi Idris Déby Itno - Abomey-Calavi  
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## DESIGN OF CONFIGURABLE DYNAMIC MESSAGE SIGN (CDMS) CONTROLLED BY A MOBILE APPLICATION

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### ATELIERA GT1/ GT A37

#### **Abstract**

LED display boards are an effective tool to disseminate information and especially to alert populations. The used (popular) LED Advertising display boards in Benin broadcast only non-modifiable information statically or with animation. The unchanged nature of the disseminated information limits the adoption of this tool which is nevertheless remarkable everywhere day and night. As nowadays, the concept of Smart city based on IoT technology is growing up fast, we propose a configurable dynamic message signs (CDMS) to make the Advertising display more profitable than the static display using posters, or ordinary signage tools.

The objective of this work is to design a LED board with changeable display in a connected environment to broadcast dynamically 24 hours information with setting options.

The proposed system is called NS-Connect and consists of two components: an electronic component and an Android mobile application. The luminescent electronic component of the CDMS is made of LEDs with high luminous efficiency. The latest advances in LED technology have made possible to minimize the Android device, and a microprocessor for controlling electronic circuits of the system. The mobile application is designed with several features concerning text edition and display settings (scrolling speed, brightness, choice the energy consumption of the system. The electronic component incorporates a Bluetooth module to communicate with of font etc.). The user can control the dissemination of information on one or more LED display boards from the NS-Connect application, running on a smartphone or tablet.

This technological innovation offers the advantage of reducing costs of awareness-raising activities and communication campaigns on major themes such as health (eg. COVID-19), environment (climate change) or civic engagement. The NS Connect Kit can be used also to disseminate information about market access.

**Keywords:** illuminated sign, LED display board, mobile application, smart city

#### **1. Introduction**

The digital revolution brings socio-cultural and economical changes including the way that people experience information, media and advertising. Web advertising, in last years, has become a vital component of the digital ecosystem ([3], [7]). Computational or mobile applications based advertising in the world of Internet of Things (IoT) is an under-investigated research field despite the advances observed in recent years. IoT advertising would enhance traditional Internet advertising and public place advertising by taking advantage of IoT opportunities ([1], [2]).

Illuminated electronic signs or LED (Light-Emitting Diode) display boards are electronic devices that are used to disseminate information in real time. LED display boards are designed in alignment with technological, and environmental trends. In [12] the adoption of LED is

recommended because “since 2003, the U.S. Department of Energy (DOE) has evaluated the lighting applications where LED technologies are having the greatest energy savings impact”. One of interesting results of IoT technology development, could be the key role of LED display boards in the shift to smart cities.

The possibility of organizing message display through local computer networks or Internet using 24 hours accessible LED signs, opens up new possibilities. The advantages of this type of awareness-raising and advertising are numerous: (i) to access the information displayed by an outdoor LED sign, the target audience does not need to buy an equipment, (ii) LED display boards provide a higher brightness and resolution than traditional screen, ensuring a high visibility of displayed messages even in broad daylight, or deep night; (iii) Outdoor LED advertising is perfect to turn passerby's into customers by captivating their attention with personalized and creative messages etc.

The use of LED boards in the area of advertising started decades ago, but the remote control of displayed messages in such systems is recent. Most of related works are based on the GSM technology, for which Bluetooth and Wi-Fi protocols are interesting alternatives ([2]). In this work, we propose a Bluetooth based system for dynamic display.

The rest of the paper is organized as follows. In Section 2 we present different works related to the topic. The proposed CDMS architecture is described in Section 3. In section 4 we report our study results and discussion, and section 5 concludes the paper.

## 2. Related works

Much research has been performed in last years to design remote control systems of LED signs. The table 1 presents the summary of reviewed works with used technologies description.

Table 1. Summary of related works with used technologies

Sign types	Description	Related works	Technologies
Electronic notice board (including LED Advertising screen)	Boards in institutions or organizations and public utility places like airports, bus stations and railway stations to display and pass information	[4], [5], [6], [8]	GSM technology
		[9]	Web, Ethernet
		[13]	Speech to text technology, Mobile app, Wi-Fi
Traffic diversion signs	Traffic diversion signs are used to communicate traffic conditions, general information, and recommended diversion strategies	[14]	Various messages strategy for specific circumstances
Emergency LED Exit Sign	Emergency Exit Sign are used to attract the immediate attention of people needing guidance for exiting	[10]	Zig Bee network

### Limits of analyzed works

Conventional LED signs do not offer the possibility of changing dynamically the displayed message.

For the first generation of dynamic message systems based on GSM technology, the displayed message is sent through a SMS. Many limits are linked to the SMS driven approach, starting with the predefined size of the message and display settings. The use of GSM facilitates the remote control of the system, but, when the system is experiencing connection troubles (this case is often in developing countries), the displayed message could no longer be modified, even if the user is nearby the display system. Also, the use of the GSM SIM is subject to a subscription, which can be cut for reasons of non-renewal and can compromise the work of the system.

In [9] an on board mounted SD card on the Ethernet shield is used to store the message to be displayed. Although the system works on a network, it lacks a remote controller.

The Zig Bee protocol used in [10] is a short range, low power communication protocol with many advantages, but the system is controlled directly by the Arduino card. This restriction is a limit to the remote control.

### 3- System architecture

A configurable dynamic message signs (CDMS) system using Android mobile application is proposed in this paper in order to make awareness-raising messages and advertising more sensitive and more configurable. The system is designed to guarantee the effectiveness of awareness-raising activities and advertising campaigns by cost reduction and time saving.

The proposed system consists of two main components communicating through Bluetooth: electronic component and software component. The use of Bluetooth is motivated by several advantages. Threat to Bluetooth devices are reported in ([11], [15]) and mitigating solutions are proposed. The analysis of authors demonstrates that the Bluetooth protocol is less exposed than the Wi-fi and its implementations tend to use less energy than Wi-Fi communication.

#### 3.1 Electronic component

Details about main devices in the electronic component are presented below:

- Max7219 circuit: a serial input /output shift Register used as LED driven circuit to control output pins.

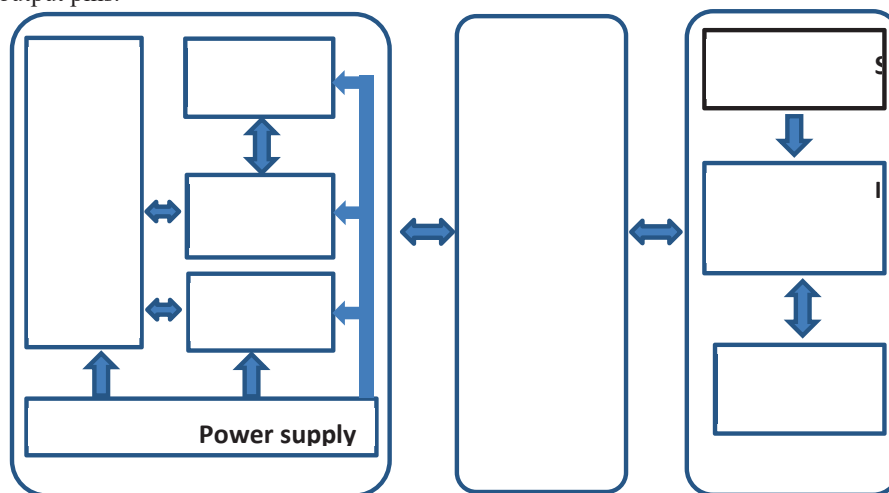


Fig.1 Architecture of the proposed CDMS system

- LEDs: used to form the led matrix;
- Capacitor 470uf 16V: used for filtering the supply voltage of the matrix;
- Terminal block: for secure matrix patching;
- Arduino nano card: allows remote control of the matrix;
- Bluetooth module: allows the communication of the Arduino card (electronic component) with the Mobile Application;
- Power supply: provides the needed electrical energy to all devices of the system;
- Jumpers: allows the electrical connection between the different parts of the system.

### 3.2 Software component

The software component is based on Android mobile application. Main services of the software components are:

- User authentication: the access to the application core is secured by a user password. The password is set when the application runs the first time.
- Message editing: with the NS-Connect App, the user can create, delete or edit a message.
- Display setting: on the message editing page, a button allows the user to display a message. Five display setting operations are possible:
  - Scroll the message or make it static;
  - Specify the scrolling speed when viewing;
  - Define the font and text size;
  - Choose the one or two lines display mode;
  - Adjust the brightness of the sign.

The figure 2 presents the circuit diagram of the system interfacing the microcontroller (Arduino nano) and the LED matrix using Proteus software.

In Figures 2 and 3, the Bluetooth module communicates with the microcontroller, which is connected to the LED display for sending received commands from the mobile application through Bluetooth protocol. All electronic equipment is connected directly to the power source which supplies them with a 5V power.

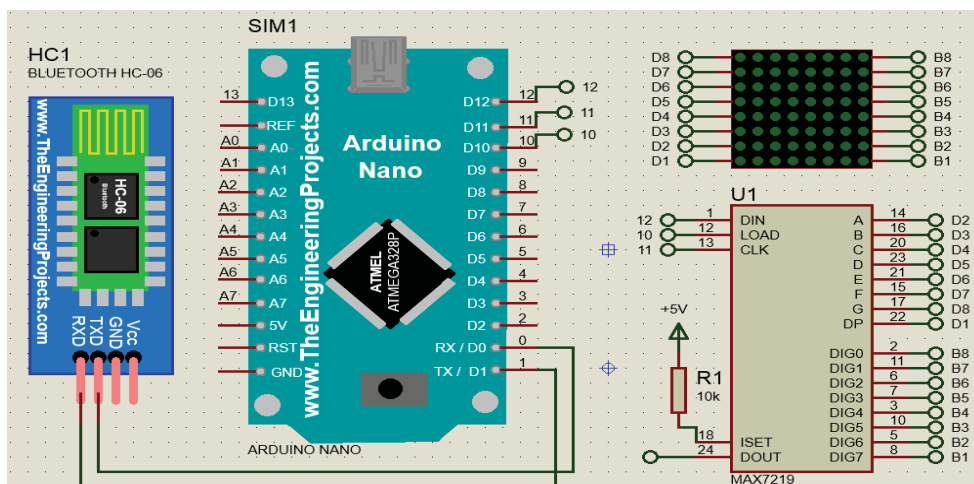


Fig.2 Circuit diagram of the system



#### 4. Results and discussions

The following photos highlight some layouts of the deigned CDMS system demonstrating some of its features.

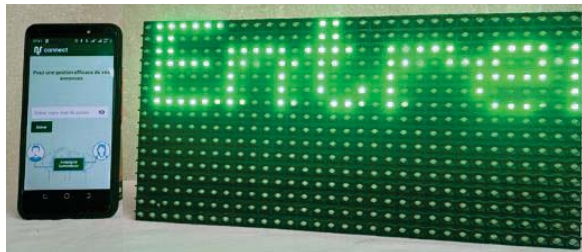


Photo 1. NS-connect kit: App and LED board

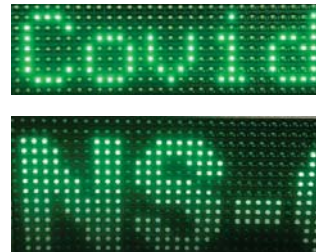


Photo 2. Text size change demonstration



Photo.3 Two lines display of input message

#### Test and empirical results

The Max7219 circuit uses a master to reset the system and clear the register. This resetting process allows new messages to be displayed on the LED screen within 100 milliseconds. The proposed mobile applications for remote control is developed in the Java programming language using the Android Software Development Kit. Displayed messages are stored in SQLite database. All message editing operations are executed without delay.

#### Security concerns

In the CDMS electronic component, the Max7219 circuit is used for multiplexing digital inputs of the LED matrix and to maintain low power dissipation. This protection circuit prevents destruction of the LED signs due to mismatched input voltages. The mobile application is protected from unauthorized access by a user authentication process using password. A mail based password reset procedure is proposed in the application. A developer code is used to protect the installation of the mobile application.

#### System applications.

The proposed IoT-oriented CDMS offers flexibility to display flash news or advertising messages in real time. The system can be used for many purposes, without affecting the surrounding environment, as:

- Outdoor Notice board at public places like municipalities, schools, hospital, shops, bus stations, railway stations, gardens etc.
- Traffic diversion signs on roads under construction. The system is particularly useful by night to limit road accidents.
- Indoor Emergency LED Exit Sign especially in big buildings to guide visitors.

## 5. Conclusion

This paper presents the architecture and the implementation of a smart configurable dynamic message sign system based on remote control from Android mobile application. The displayed messages are transmitted to a LED board through a microcontroller using Bluetooth protocol. One of the new features of the system is the possibility of dynamic display setting from the mobile application. Main Advantages of this innovation are time saving, cost effectiveness and the 24 hours possibility of reaching the target audience. The LED technology is robust and guarantees the sustainability of the proposed system.

Aware of the Bluetooth's range limits, in perspectives, we plan to introduce the Wi-fi protocol to the NS-connect system implementing required security principles to provide long distance control.

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