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Communication between Man and Machine: Application of Artificial Intelligence in the Field of Road Regulation

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Abstract:- We describe the importance of artificial intelligence to overcome the human resource deficit in the field of road traffic regulation. Thanks to the communication between man and machine, the rolling robot has been able to provide an answer to the monster traffic jams observed on the arteries of Kinshasa but also to the fatal accidents deplored during off-peak hours on several crossings of the roads of the capital.

The rolling robot or intelligent rolling robot is an android robot regulating road traffic on several streets of Kinshasa, developed by Thérèse IzayKirongozi[1] and the Congolese association of engineers Women's technology. It is equipped and powered by a solar panel. Since the invention of this android robot to regulate traffic, it now rolls in Kinshasa, Lubumbashi, and Goma. And soon maybe all over the continent... Each android robot, packed with electronic components, equipped with cameras and equipped with solar panels, measures 2.50 m in height and weighs 250 kg.

Indeed, these robots have the mention: "Made In Congo" to say manufacture locally. It has all the faculties that a human can possess to guide the passage of vehicles. It consists of an aluminum assembly to protect the equipment from dust, a solar panel to supply it with energy, integrated cameras to record traffic violations and a set of elements that receive light (sensors).

The intelligent rolling robot is not perfect, and it proves some limitations of which it should be added new functionality.

Thanks to the semiotics of Communication, we studied the interactions between man and machine and the impact of this communication on road traffic. Using the Mathematical Theory of Information, with the model of Shannon and Weaver (1948) and that of Lasswell (1948), we have demonstrated in this article the process of this human-machine communication. We also unpacked the limitations related to the lack of feedback that make artificial intelligence an additional problem instead of a solution considered.

Keywords:- *Rolling robot, human-machine communication.*

I. INTRODUCTION

The city of Kinshasa, capital of the Democratic Republic of Congo, is a megalopolis located in the west of Middle Africa. With its twelve million inhabitants, the vast city province of Kinshasa has 24 communes with the highest population density in the eastern part of the city, Tshangu district. [23]

However, all the political institutions of the country as well as all the commercial activities of the city and the majority of the best schools, are concentrated in the municipality of Gombe. Almost all the inhabitants of Kinshasa leave the 23 communes of the capital, heading to Gombe for their daily activities.

In addition, secondary roads are mostly impassable and all the city's rolling stock circulates only on the main arteries widened since 2007 by Chinese companies as part of the five-construction program. This causes monster traffic jams during rush hour, and fatal accidents during off-peak hours. [4]

To face the enormous challenges related to road traffic, innovation in artificial intelligence through the driving robot has been a solution since 2012. How is the communication between road users and the robot driving at the intersection of the avenues des huileries and triomphale? And what is the result?

Our article will address the problem in two main points:

- The rolling robot and road traffic in Kinshasa
- Analysis of the interactions between the driving robot and road users at the intersection of Avenue des huileries and Boulevard Triomphal

And to achieve this, our theoretical and methodological approach will focus on the semiotics of communication in order to study the functioning of the rolling robot, the decoding by road users of encoded signals as well as the impacts related to communication disturbances. We will also use the Mathematical Theory of Information, with the model of Shannon and Weaver (1948) and [56] that of Lasswell (1948) to explain the process of this

[1]Arthur MALU-MALU, DRC: Thérèse Kapangala and its Robot 100% made in Congo" Article Jeune Afrique, taken from the Dossier "DRC: the big maneuvers", November 10, 2015

[2]Augustin MANGEMOSI, *The new geopolitics of Africa median*, Kinshasa, I.P.R.I.S. 2016, P.22

[3]Institut National de la Statistique, AnnuaireStatistique 2015, Kinshasa, Ministry of Planning, March 2017, p.

[4] David VAN REYBROUCK, *Congo A History*AmsterdamAcyes South, 2012, p. 678

[5] PEIRCE C S. : Ecrits sur le signe, Ed. Seuil, Paris, 1978, pp. 25-26.

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human-machine communication, and to dismantle its limits related to the lack of feedback.[7]

II. THE ROLLING ROBOT AND ROAD TRAFFIC IN KINSHASA

The problem of traffic jams in Kinshasa finds its causes in the very structure of the city. The first cause is the configuration of Kinshasa's roads. The second, Kinshasa is a city that works one-way, like an hourglass.

Indeed, the vast city of Kinshasa operates in two funnels, like an hourglass: the first includes almost all the communes in the east of the city, Maluku a Limete, through Nsele, Kimbanseke, Ndjili, Masina, Matete, Kisenso, Lemba, Ngaba, Makala, and part of Kalamu. That is, thirteen municipalities that dump their populations into the eastern funnel through two canals: Lumumba Boulevard and University Avenue. This mass poured by these two avenues rushes into the pipe of the funnel which is the boulevard Sendwe then triumphant. This funnel fortunately has some leaks including the outlets of the avenues of the Poids Lourdes and Bokasa (now Luambo Makiadi).

The second funnel, in the opposite direction, also includes the communes of the West such as Mount Ngafula, Selembao, Bumbu, Bandalungwa, Ngiri-Ngiri. This mass is drained by the former avenue 24 novembre from the UPN to pour into the pipe that constitutes the boulevard Triomphal, before finding the other part, that is to say the population of Kintambo, Gombe, Ngaliema, Lingwala, Kinshasa, Barumbu that drains the arc of the avenue Kasa-Vubu and whose bottom shares the same pipe as the funnel East, that is to say the boulevard Sendwe. In all, the populations of eleven municipalities use this route to cross the city. This funnel also has some leaks such as Dima Avenue, on the left, and Victory Avenue which, in any case, once again pour their contents into the East funnel.

Thus, the heart of Kinshasa is not the Victoire roundabout as some think, but rather the rolling robot that regulates traffic at the intersection of the avenues des huileries and Triomphale. This robot is the point of intersection between the two pipes of the two funnels East and West which are respectively Sendwe Boulevard and Triumphal Boulevard. The junction of these two avenues constitutes the backbone of Kinshasa where all the major avenues come to rush, a corridor where the major avenues such as November 24, Kasa-Vubu, University and Lumumba pour their contents. This causes monster traffic jams at this place of intercession, especially at a time when the rolling robot did not yet exist.

The second reason for traffic jams in Kinshasa is that the city operates one-way. This is due to the inequitable distribution of services throughout the city. These include: services such as administration, banks, markets, universities, etc. that Kinois need and that justify their daily travel. The municipality of Gombe concentrates almost all of these services to such an extent that, every day, people have to move in the morning in the same direction to access these services and, in the evening, the hourglass is overturned and everyone takes the opposite direction to go home. And it is in this context that the rolling robot is very useful for road regulation in the Congolese capital.

A. Semiotic study of the rolling robot

Fig. 1: Thérèse Izay and her 100% “made in Kin” robot

The traffic lights incorporated into these driving robots probably ensure road traffic instead of the police. This example of traffic lights Like all disciplines, semiotics shows, describes and explains the complexity of complex or seemingly simple phenomena. The traffic lights contained in the robot constitute an example of a simple semiotic model but already more complicated than it seems. The robot works by rotating and spreading its arms horizontally while displaying green, amber or red lights to regulate traffic.

To fully understand the semiotic process, we use, with Louis Hebret, a field that touches and interests (almost) everyone: the automobile... The three main signifiers of traffic lights are each associated with a color: yellow, red and green, using only one of the five senses: sight (as opposed to auditory, olfactory, tactile and/or gustatory signs). More precisely, it is the physical stimuli associated with these signifiers that pass through these sensory channels. In the same signage, the lights must respect the sufficient safety margin, and our analysis here focuses mainly on road safety...We speak of a semiotic margin of safety between one sign and another, one signifier and another, one signified and another, one physical stimulus and another, etc., a margin which must be sufficient to distinguish them. For example, in principle, traffic lights could use the following three colors instead of green, yellow and red: dark, medium and light green.[8]

[6]Heurley L., Mathematical theory of communication (information theory) and cognitive psychology, University of Picardie Jules Verney, 2013, p.2-8

7 Buhler Michael. Study designs and communication models. In:*languages and communication*,n°24, 1974. pp. 31-43.Two : 10.3406/colan.1974.4152

[8]Arthur Malu-Malu, «DRC: Thérèse Kapangala and her Robot 100% made in Congo », Young Africa article, taken from the Dossier: *DRC: the great maneuvers*, of November 10, 2015

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It should be noted that the slightest margin of safety between these physical stimuli and the signifiers that correspond to them would also reduce road safety... Colors are often associated with other types of visual signifiers (associated with the same signifieds as colors), which creates redundancy and noise in traffic lights. This association produces a semantic redundancy: the phenomenon of repetition of the same content (signified), either by its association with several signifiers, or by the repetition of the sign contained.[9]

Note that there is also expressive redundancy (redundancy of signifiers and phemes). Redundancy aims to counter what is called, in information theory, noise, that is to say what prevents or could prevent the transmission and correct interpretation (or reception) of the message produced during the broadcast or production, we will see this in the following points. The redundancy aims to ensure that the receiver (driver or pedestrian) perceives the sign, especially when the circumstances are unfavorable (glare, color blindness, distraction, etc.), in order to ensure that at least one of the repeated signs is perceived. Each color of the lights is associated with a single meaning, distinct from that of the other colours: "drive" for green, "prepare to stop" for yellow, "stop" for red. When two or more signifieds are associated with the same signifier, we speak of polysemy.

Otherwise, it is called monosemy. And in the context of the rolling robot, the traffic lights are accompanied by another redundancy consisting of the movement of the robot: its pivoting and the horizontal spacing of its hands to reinforce the understanding of the lights and thus avoid any noise. The robot also has a voice option that is currently inactive. He can therefore ask motorists to stop or go by voice. This power-consuming option has been disabled.

In addition, traffic lights, like those contained in the rolling robot, are monosemic.

“Polysemy” receives a particular meaning, a less accentuated form of difference between signified than in homonymy. Thus, the signifier mouth can be associated with two signified in a relationship of polysemy, “metro mouth” and “oral orifice”. On the other hand, the false signifier can be associated with two signified in a homonymous relationship: 'agricultural instrument' and 'erroneous'.

We speak of synonymy, in linguistics, when two signifiers or more correspond to the same signified. For example, "to die" and "to pass away" have the same meaning. In the semiotic system that interests us, we find “synonyms”: the red light + the horizontal spreading of the hands by the robot equivalent to stopping moving, even if they are less important.[10]

B. Visual communication of the rolling robot

At the intersection of the avenues des huileries and the boulevard triomphal, a rolling robot is positioned there and ensures the traffic of the road. Thanks to these three traffic lights and the rotating movement in the vertical and horizontal direction, the driving robot transmits a clear signal to road users in three semiotic instructions:

- When the light is green: the robot recommends users to circulate freely because the way is free
- When the light is orange: the robot requires a slowdown in traffic because there could be vehicles also in the cross-direction and this could cause either traffic jams or even collusion by inattention.
- When the light is red: the robot asks vehicles to stop squarely because the lane is occupied by vehicles traveling in the cross. He even spreads his arms horizontally to reinforce his message.

These three lights are reinforced by the rotary movement of the robot which will allow even a user unable to decode the meaning of the lights to understand whether to circulate or stop.

The robot is also equipped with visual and verbal technology but not activated because of the technical requirements related to these options.

At the crossroads in front of the Parliament - in the heart of the megalopolis of 10 million inhabitants - the "Spirits of Death", these famous dilapidated passenger buses, cars and motorcycles spin at full speed on the four axes distributed by this roundabout. But when in the middle of the crossing, a giant robot, which seems straight out of the movie "Back to the Future", pivots on itself and raises its arms horizontally, everyone stops. « *It's our rolling robot* " exclaims a smiling motorist, " *We like it, so we respect it!* »[11].

Since October 2013, this 2.50 m aluminum character, powered by a solar panel, replaces the police officers responsible for regulating traffic and animates the intersection in front of Parliament with his daily ballet. Every 5 minutes, he rotates his bust, his breastplate changes from green to red and he places his arms horizontally as an officer would block one lane and let cars pass on the other.[12]

It must be recognized that the advent of the rolling robot in Kinshasa has significantly reduced traffic accidents previously deplored in the city.

[9]Louis Hébert, « Introduction to Semiotics », in *Signo*, Rimouski, Quebec, version of December 14, 2018.
[10] Louis Hébert, « Introduction to Semiotics », in Op. Cit.
[11]Leah-Lisa Westerhoff Hotels, RDC: REMP robots Lace the police a Kinshasa, RFI-Africa report published March 19, 2014
[12] ditto

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III. ANALYSIS OF THE INTERACTION BETWEEN THE ROLLING ROBOT AND ROAD USERS AT THE JUNCTIONS OF THE TRIUMPHAL OIL MILLS

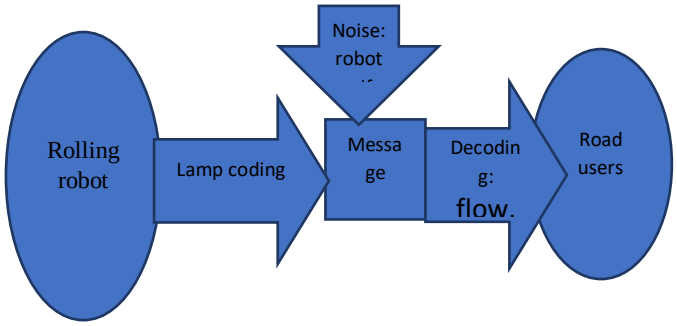

Fig. 2: Diagram of analysis of interactions between the roto and the driver of the road

Before any analysis, it should be noted that the interaction between the rolling robot and road users follows the **communication model of Shannon and Weave**r.

Indeed, the model of Shannon and Weaver (1948), Shannon engineer, Weaver a philosopher, was interested in the question of telegraphic transmission. In this case, a signal emitted by a source and intended to reach a target but regularly jammed by all kinds of external phenomena. [13]

The theory is interesting because it highlights the obstacles that can make communication difficult, decoding or noise in this case. On the other hand, it is regrettable that it is based only on simple messages while ignoring the plurality of receivers, psychological elements and interactions between the sender and the recipient.

In the light of this model, the driving robot transmits a coded signal that contains a very precise message and must be decoded by the road user. Power cuts, robot malfunctions are part of the schematized noises in this model.

Clearly, the message encoded by the driving robot is contained in the three traffic lights it sends as a signal. These are the green light, the orange light and the red light. The movement of the rolling robot by gestures usually used by police officers reinforces the understanding of the information encoded in traffic lights.

Once this message is transmitted by the robot, the road user decodes it and executes to circulate on a junction without causing traffic jams or accidents. When the driving robot gives it the green light, the road user decodes that the lane is open and the vehicle can pass. When the light is orange, it means slowing down while crossing and be careful because another vehicle could come from the other direction and when the light is red, the driving robot invites road users to stop while waiting for the lane to be opened.

However, such human-machine communication has presented many limitations due to the fact that the operation of the robot is automated and programmed upstream but generally does not take into account the spontaneous and unexpected reality of the road. It happens very sometimes that the robot gives access to road users while the intersection is already blocked by vehicles looking for passage. A situation that further reinforces the cork instead of rejuvenating it. This generally marks the limits of artificial intelligence and requires the presence of a traffic policeman to relieve congestion at the intersection. And this is exactly what is observed at the Parliament Roundabout or in addition to the Driving Robot, some police officers are also positioned there to ensure the proper regulation of the road in case of confusion caused by the operation of the robot and phase shift with the reality of the road.

These disturbances in human-computer interaction are mainly due to the very design of the interactive system that does not take into account certain human factors. As a result, faced with a small change, the communication aspect becomes totally chaotic. Hence the need for an interactive approach.[14]

Indeed, an interactive system works with information provided by an external environment that it does not control. It is an open system, as opposed to autonomous systems whose operation can be entirely described by algorithms It generally maintains an internal state, the least part of which is perceptible to the environment.[15].

A. The fluidity of road traffic thanks to good communication between the driving robot and road users

In human-machine communication, the interactive approach depends mainly on ergonomics. "Ergonomics, being a scientific discipline studying human factors, aims at the complete understanding of the interactions between human beings and the other components of a system. It also consists in the implementation of the design of theories, principles, methods and relevant data to improve the well-being and the overall efficiency of the systems." (2001)[16]

In context of the fluidity of circulation between man and machine, ergonomics aims to understand the interactions between road users and driving robots in order to ensure the optimization of the well-being of people and the overall performance of systems that must be: – Efficient – Reliable, safe – Favorable to the safety of their users – Favorable to the development of their skills.

By carefully observing the apparent interaction between the robot driving and road users at the intersection of the avenues of the oil mills and the triumphal boulevard,

[13]Heurley L., Mathematical theory of communication (information theory) and cognitive psychology, University of Picardy Jules Verney, February 2013, p. 2-8

[14] C a t h e r i n e Recanati, Human-Computer Interaction, University of Paris 13, Master 2 Course Note, p. 11

[15]Nicolas Roussel, Introduction to Human-Computer Interaction, University of Lile, 2012, p. 53

[16]C a t h e r i n e Recanati, Human-Computer Interaction, University of Paris 13, Master 2 Course Note, p. 15

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we can to some extent admit that this interaction obeys the **Laswell model**[17].

Indeed, researcher Harold Dwight Lasswell was one of the first to take an interest in mass communication. According to his theory, any communication action is fundamentally based on five main points:

- **Who?:** or the study of issuing bodies and their motivations.
- **What?** : or visualidentity, the content of the message.
- **By which channel?** : or the techniques used to spread that specific message.
- **Whose?** : or the target audience (age, gender, etc.).
- **What effect?** : or the impact of the message on the intended interlocutors.
- The Lasswell theory is therefore a little more inclusive than the Shannon and Weaver method in that it conceives communication as a **process of influence and persuasion.** The absence of any form of feedback (feedback from the sender to the receiver) or context still leaves it reductive too.

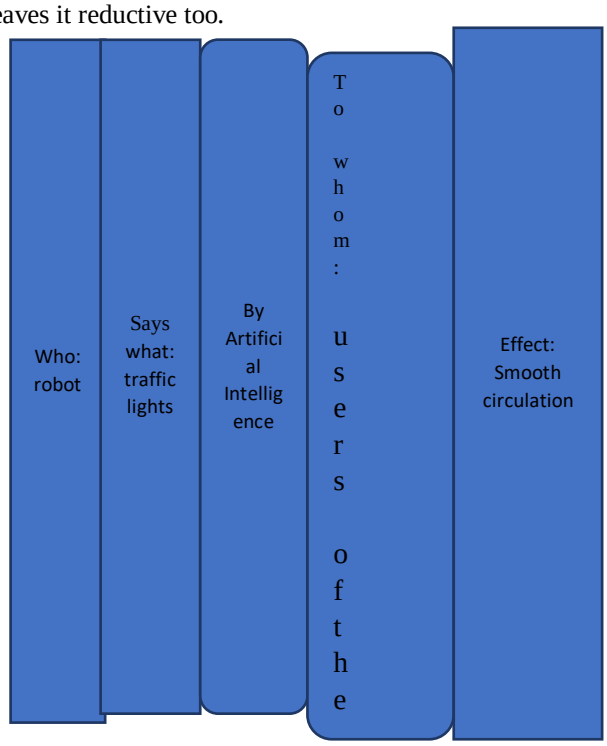

Fig. 3: Diagram of the correct communication process between the taxi robot and the road user

Considering the context of the rolling robot at the crossroads of Avenue des Huilerie and Boulevard Triomphal, it appears that it is indeed a mass transitive communication. In fact, the driving robot represents the policeman the transmitter who ensures the smooth circulation of the road.

The encoded traffic lights constitute the what, the very content of the message, transmitted here in an artificial intelligence channel, thanks to an algorithm of communication by the machine to the man. And although transmitted by a machine, the message has an immediate effect on all road users affected by this message. If the light is green, everyone is convinced to drive and when it is red, everyone stops at the same time.

The fact that the robot does not know how to capture feedback from road users, for example when there is a misunderstanding causing a traffic jam on the intersection, continues the weakness of this communication.

Nevertheless, it must be recognized that thanks to the installation of a driving robot at this place, monster traffic jams observed there long before almost no longer exist, and traffic has become fluid except at rush hour when it requires the presence of police officers to assist the robot.

B. Difficulties related to traffic communication disruption

As we said in the previous point, this Lasswell model has weaknesses in terms of lack of feedback. In the context of this communication robot driving and road users, the fact that the robot is not equipped with feedback technology makes communication deficit. It very often happens that the robot gives access to vehicles in the horizontal direction, while the intersection is still crowded by vehicles crossing between the vertical direction and those coming from the vertical to pour into the horizontal.

The immediate opening of the other direction without waiting for the decongestion of the intersection generally makes traffic much more complicated. This sometimes causes monster traffic jams. In such a context, the robot is no longer perceived as a traffic regulator but rather as a disruptive agent.

This requires common sense from road users to recognize the limits of the machine and wait for the way to open before entering it. But generally, as everyone is in a hurry, road users do not keep in mind the limits of the machine and simply execute the information communicated to them. To normalize the situation, it takes the intervention of a human, a traffic policeman.

It is the same when the driving robot malfunctions or when road users do not obey the instructions dictated by the robot. This causes total traffic jams.

To compensate for this type of malfunction, some traffic police officers are also positioned at this location in support of the robot. No longer being the main road enforcement officer, except in cases of malfunction, these elements of the police then turn to ransoming road users, road harassment and some to awareness. It looks a bit like disguised unemployment for the police officer assigned there.

The ideal in such a context would be to deepen research to improve the rolling robot. This would avoid certain malfunctions. The improvement of this robot will necessarily move from the linear design of machine-human communication to circular design.

[17]MEUNIER JP and PERAYA D, (1993), Introduction to Communication Theories, De Boeck-WesmaelNeck. Culture and Communication, Brussels.

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The ecological approach to perception, due to psychologist J.J. Gibson [GIB 79], has developed the notion that human beings extract information from their environment to produce work (in the physical sense) and act on the environment. This global approach, which considers the animal and its environment (the user and the interactive system in our case) begins to have an increasing importance in HMI and forms the basis of an ambitious research program.

A better understanding of the links between the information processed by our computers (Shannon's) and the information processed by our senses (Gibson's) can be a key to creating innovative interactive systems.[18]

Research in artificial intelligence should therefore focus on this avenue in order to further improve communication between machine and man and thus avoid communication disruptions likely to create more problems than solutions.

IV. CONCLUSION

Communication between machine and man is limited. When the machine does not work, there is incommunication.

Artificial intelligence can only be useful for society when there is good communication between man and machine. Otherwise, artificial intelligence becomes a real bomb for society.

However, human-computer interaction is a very rich field, moreover constantly evolving, in connection with the new Sciences and Technologies of Information and Communication. Many methods, techniques, architectures and knowledge are available, the tools also evolving very quickly.

For the most part, the aspects reviewed are usable or adaptable for the design or evaluation of interactive transport applications, both on the operator and user side, as the need for new interactive applications is growing. It is important to teach them as much as possible systematically in designer training.

Many perspectives can be highlighted without concern for exhaustiveness, related to: the integration of new concepts related to human factors in software engineering and automatic engineering methods and models, better consideration of collective work, facilitating interactions between actors, human-machine and human-human cooperation, making HMI increasingly ergonomic, intelligent, personalized, multimodal, to make available to nomadic users new activity supports. Wearable computing, virtual reality, and reality[19]

And the field of road traffic that we have addressed in this work with the contribution of the driving robot in the fight against traffic jams and accidents on the arteries of Kinshasa is a success to date, even if a work of improvement deserves to be done. The rolling robot positioned at the Rond-Point Parlement demonstrates Congolese ingenuity in the field of artificial intelligence.

REFERENCES

[1.] Arthur Malu-Malu, "DRC: Thérèse Kapangala and her Robot 100% made in Congo" Article Jeune Afrique, from the *DRC Dossier: the major maneuvers*, November 10, 2015

[2.] Augustin Mangemosi, *La nouvelle géopolitique de l'Afrique médiane*, Kinshasa, I.P.R.I.S. 2016.

[3.] Buhler Michael. "Study Designs and Communication Models". In *Communication et langages*, n°24, 1974. pp. 31-43. DOI: 10.3406/colan.1974.

[4.] C a t h e r i n e Recanati, *Human-computer interaction*, University of Paris 13, lecture note master 2.

[5.] Christoph Kolski, Methods and Models in Human-Computer Interaction, Applications in Transport, Polytechnic University Hauts-de-France, 2007.

[6.] David Van Reybrouck, *Congo Une histoire*, Amsterdam, Acyes Sud, 2012.

[7.] Heurley L., *La théorie mathématique de la communication (théorie de l'information) et la psychologie* cognitive, Université de Picardie Jules Verney, 2013.

[8.] National Institute of Statistics, *Statistical Yearbook 2015*, Kinshasa, Ministry of Planning, March 2017.

[9.] Léa-Lisa Westerhoff, *DRC: robots replace police officers in Kinshasa*, RFI-Afrique report published on March 19, 2014.

[10.] Louis Hébert, "introduction to semiotics", in Louis Hébert (ed.), Signo [online], Rimouski (Québec), version of December 14, 2018, http://www.signosemio.com/introduction-semiotique.pdf

[11.] MEUNIER Jean-Pierre, PERAYA Daniel, *Introduction aux Théorie de la*Communication, De Boeck-Wesmael, Coll. Culture et Communication, Brussels, 1993.

[12.] Michel Baudouin Lafon, « Enjeux et perspectives en interaction homme-machine », In *interactions machine et homme*, insitu.lri.fr.

[13.] Nicolas Roussel, *Introduction to Human-Computer Interaction*, University of Lile, 2012.

[14.] PEIRCE C S. : *Ecrits sur le signe*, Ed. Seuil, Paris, 1978.

[15.] Editorial Zoom Eco, *KINSHASA : Vignette 2016-2017, public authorities should lead by example!* Press article of 28 December 2017.

[18] Michel Baudouin Lafon, Enjeux et perspectives en interaction homme-machine, in interactions machine et homme, insitu.lri.fr, p.5

[19] Christoph Kolski, Methods and Models in Human-Computer Interaction, Transport Applications, Polytechnic University Hauts-de-France, 2007, p. 6