RUFORUM Working Document Series (ISSN 1607-9345), 2018, No. 17 (2): 115-119.
Available from http://repository.ruforum.org

Research Application Summary

Exploiting the 5G network opportunities for enhancing food security

Amitu, D.M., Otto, F. & Kato, J.

Regional Universities Forum for Capacity Building in Agriculture (RUFORUM), P. O. Box 16811, Wandegeya, Kampala, Uganda
Corresponding author: d.amitu@ruforum.org

Abstract

Tackling the food insecurity problem from all angles so that fewer people go hungry every year will help the majority of the population focus on economic development. With the next generation networks expected to provide extensive coverage to even hard to reach areas, extremely high speeds, and massive machine to machine communications, integrating smart mechanized agriculture with the next generation network technologies in the food security efforts becomes inevitable. With these opportunities presented by the next generation networks in mind, this paper explores how the fifth generation (5G) network opportunities can be harnessed for increased agricultural productivity and a food secure population.

Key words: 5G, 4G, agriculture, food security, information and communication technologies

Résumé

La gestion de l'insécurité alimentaire sous tous ses angles aidera la majorité de la population à se concentrer plus sur le développement économique. Avec les réseaux de génération future, censés fournir une couverture étendue même dans les zones difficiles d'accès, des vitesses extrêmement élevées et des communications massives d'une machine à une autre, l'intégration d'une agriculture mécanisée intelligente avec les technologies de réseau de nouvelle génération dans les efforts de sécurité alimentaire devient inévitable. En gardant à l'esprit ces opportunités présentées par les réseaux de nouvelle génération, cet article explore comment les opportunités de réseau de cinquième génération (5G) peuvent être exploitées pour accroître la productivité agricole et une population en sécurité alimentaire.

Mots clés: 5G, 4G, agriculture, sécurité alimentaire, technologies de l'information et de la communication

Introduction

Food insecurity is a growing problem in many parts of the globe, especially in Africa where weather and climate are still key factors in agricultural productivity (Parry *et al*., 1999). Active integration of Information and Communication Technologies (ICTs) into Agriculture could help to reverse this trend, particularly the next generation networks like the fifth generation (5G) wireless broadband technology. The 5G is the successor of the 4G network and it will mainly be characterized by three new aspects of greater data speeds, lower latency, and the ability to connect a lot more devices at once. So generally,

the 5G network is expected to improve on the speed and coverage beyond the current 4G network with low latency wireless up to 1Gbps and is expected to provide reliable, high bandwidth speeds to rural areas that typically lack coverage (Gupta and Jha, 2015). This will enable new precision agriculture (Bongiovanni and Lowenberg-DeBoer, 2004) capabilities on-farm equipment leveraging real-time connectivity as earlier envisaged by McBratney *et al*. (2005). Additionally, with the evolution of machine type communications (MTC), the notion of farm equipment communicating with each other and other machines on the field by streaming data from machine to cloud and back down to machine operators in the shortest time possible will finally be a reality. Indeed, 5G network will transcend smartphones and connect anything from vehicles, machines and home appliances at speeds 50-to-100 times faster than present 4G networks. It will also offer lower lag times when transferring data. In order to exploit these opportunities presented by the 5G, its integration with agriculture becomes inevitable and consequently leading to the notion of smart agriculture with a goal of tackling food insecurity. For successful transition from the current 4G network to the 5G network technology, there are key drivers. These largely determine whether these technologies will be widely used for smart agriculture. These key drivers are elaborated below.

Network speeds. ICT platforms for smart agriculture require fast and reliable wireless internet connection. The current technologies in place massively fail due to higher demand even in areas with high speed connections and this is partly because they were not designed for massive Machine Type Connections. Therefore, the current technologies are not advanced enough to cope with the data quantities and speeds required for smart-farming. In order to provide a stable connection, carriers need to utilize developing technologies such as massive Multiple Input Multiple Output (MIMO) and network slicing as well as using small-cells or similar to provide stable connectivity over large distances.

Coverage. A lack of a comprehensive rural broadband in most rural areas poses a big challenge to the progress of smart farming. This is why RuralFirst (Speirs, 2017) was among the first projects to be funded because it illustrated that 5G could address many rural issues including coverage in a way that 2G, 3G or even 4G have been unable to until now.

Cost. The network generations have been evolving from 2G, 3G up to the current 4G but the cost of infrastructure and end user devices has remained relatively high. Therefore, there is need to build a next generation cost effective network that will cater for both urban and the rural population and with easy integration into smart agriculture. Also at radio access level, carriers must work towards reducing the energy consumption, increase reliability, and improve on spectrum efficiency.

Increasing population. Smart farming is absolutely necessary to help to feed an ever-increasing population struggling with the impact of climate change but with existing infrastructure it will not be possible hence justifying the need for the next generation network.

Opportunities presented by 5G technology for enhancing food security

Crop state real-time updates. With the increasing food insecurity problem, farms will need to keep up to date with the global crop requirements. For this to become a reality, next generation smart agricultural sensors can be deployed to enhance production, minimize waste and costs and improve resource consumption. The ability to monitor soil conditions in which the latest crop is planted through a smartphone or tablet is something most farmers would jump upon if given the chance.

Smart Irrigation Systems. Smart irrigation schemes are among the essential components in the bid to reduce food insecurity because of their ability to optimize the water usage which is a critical irrigation resource. In exploiting the presence of the next generation networks sensors, farmers could access data collected from remote sensors to determine the how much, where, how long water can be applied for irrigation all from their connected laptop, tablet or smartphone.

Livestock Monitoring. Tracking the movements of livestock physically often turns out to be a challenging task because animals often tend to wander off. But using Internet of Things (IoT)-enabled sensors producing real-time livestock data such as GIS/GPS positioning, farmers will be able to keep track of even the most determined-to-travel animals. There are even systems being developed that provide real-time biomedical data on livestock such as body temperature, pulse and even tissue resistivity which could further provide the health condition of most of the livestock.

Controlled fertilizer application. The application of fertilizers, soil amendments and other products typically needed by farmers into soil is critical in most times because it has a significant impact on yields. But with sensor controlled fertilizer application, farmers could remotely control the quantity of fertilizers applied. It would also enable them to monitor fertilizer concentrations and other environmental conditions, such as soil pH using remote sensors and effect adjustments if necessary.

Drone crop monitoring. With massive integration of aerial, vehicular and machine type communications into the next generation network, monitoring a vast field to expose issues related to soil variations, disease occurrence and irrigation requirements will no longer be challenging and costly to achieve in a timely fashion. In addition, with a continued development of cheap drones, equipped with MEMS sensors, inexpensive but powerful processors, GPS and radio technologies, farm monitoring will not only be affordable but very precise.

Challenges

Despite the opportunities presented by the next generation 5G technologies to agriculture, there are still a number of challenges that need to be looked into before these technologies can fully be exploited. These challenges are highlighted below:

Slow transition to mechanized agriculture. Most of the opportunities explained above can fully be exploited in the mechanized agricultural environment. Many parts of the world and particularly in Africa unfortunately still lag in mechanized agriculture.

Limited research support. Through research, agricultural higher education institutions are in position to provide requisite knowledge and technologies to farmers that support agricultural productivity. Use of ICT is most likely to support community-based participatory research and to treat knowledge as an action strategy for change and rendering visible of the excluded knowledges around the globe in what Hall and Tandon (2017) refer to as decolonization of knowledge. But some parts of the world have limited research outputs, partly because of inadequate support for research.

Additional infrastructure. The 5G network will require additional infrastructure (Monserrat *et al*., 2014). This is likely to be a big challenge in most developing economies as this expenditure is usually transferred to the end users who are already struggling to meet the day-to-day basic needs.

Inadequate skills. In order to fully exploit the potential presented to smart farming by the next generation technologies, well skilled personnel are needed for technology transfer to the local communities. Currently,

there are skills gaps in this area in most regions of the e globe both for the developing and developed economies (White, 2017).

Recommendations

In order to address some of the challenges highlighted above, some recommendations are made below:

- Governments should increase research funding especially in areas and/or pilot projects where technology has a potential to boost agricultural productivity.
- Education and research institutions should promote skills transfer by training high quality graduates with ability to train farmers in the remote communities.
- Governments should provide tax subsidies on technology infrastructure with potential to boost agricultural productivity so that the high costs are not indirectly transferred to the farmers.
- Governments should promote agricultural advisory services which advocate for a shift from rudimentary farming techniques to modern farming methods that can easily be integrated with next generation network technologies.
- Governments should provide tax waivers to service providers who are providing rural connectivity to hard to reach areas.
- Telecommunication service providers should promote awareness by showcasing the applications of the network technologies in agriculture and sponsoring university pilot projects specifically where technology has a potential of enhancing smart agriculture.

Conclusion

The active research areas in regards to the 5G network have largely focused on the network side with little involvement of agriculture. But a high speed network on a hungry population will be under-utilized and this is why this paper highlights some of the opportunities that 5G technology presents and can be exploited to enhance food security. Knowing that not all is green, we then give some of the challenges and key drivers for the 5G technology integration into agriculture.

Acknowledgement

This paper is a contribution to the 2018 Sixth Africa Higher Education Week and RUFORUM Biennial Conference.

References

Bongiovanni, R. and Lowenberg-Deboer, J. 2004. Precision agriculture and sustainability. *Precision Agriculture* 5:359-387.

Gupta, A. and Jha, R.K. 2015. A survey of 5G network: Architecture and emerging technologies. *IEEE Access* 3:1206-1232.

Hall, B.L. and Tandon, R. 2017. Decolonization of knowledge, epistemicide, participatory research and higher education. *Research for All* 1:6-19.

McBratney, A., Whelan, B., Ancev, T. and Bouma, J. 2005. Future directions of precision agriculture. *Precision Agriculture* 6:7-23.

Monserrat, J.F., Droste, H., Bulakci, O., Eichinger, J., Queseth, O., Stamatelatos, M., Tullberg, H., Venkatkumar, V., Zimmermann, G. and Dotsch, U. 2014. Rethinking the mobile and wireless network architecture: The METIS research into 5G. Networks and Communications (EuCNC), 2014. European Conference. IEEE. pp. 1-5.

Parry, M., Rosenzweig, C., Iglesias, A., Fischer, G. and Livermore, M. 1999. Climate change and world food security: a new assessment. *Global Environmental Change* 9:S51-S67.

Speirs, S. 2017. Leading in 5G: Taking 5G to Orkney and Somerset – Part 1. Available from: https://blogs.cisco.com/sp/leading-in-5g-taking-5g-to-orkney-part-1 [Accessed May 22 2018].

White, S. 2017. Digital skills and 5G centre stage as precision farming vies to enter mainstream. EURACTIV. https://www.euractiv.com/section/agriculture-food/news/digital-skills-and-5g-centre-stage-as-precision-farming-vies-to-enter-mainstream/