ISSN 2278-3091
Volume 9, No.1.3, 2020
International Journal of Advanced Trends in Computer Science and Engineering
Available Online at http://www.warse.org/IJATCSE/static/pdf/file/ijatcse4191.32020.pdf
https://doi.org/10.30534/ijatcse/2020/4191.32020

RFID Controlled "GG" Pieces Ranking Detection with Watch-Dog Enable

Cherry D. Casuat[1], Alvin Sarraga Alon[2],Jesusimo L. Dioses Jr.[3], Rhowel M. Dellosa[4],Renante A. Diamante[5]

[1]Technological Institute of the Philippines, Manila, Philippines, ccasuat.cpe@tip.edu.ph
[2]Technological Institute of the Philippines, Manila, Philippines, aalon.cpe@tip.edu.ph
[3]Isabela State University, Echague, Isabela, Philippines, jdiosesjr@gmail.com
[4]Technological Institute of the Philippines, Quezon City, Philippines, rdellosa.cpe@tip.edu.ph
[5]Iloilo State College of Fisheries, Iloilo City, Philippines, rdiamantetip@gmail.com

ABSTRACT

This paper aims in developing a piece ranking detection of game of the generals board game that has low power consumption. Watch dog timer was used to build a low power board game that was applied in game of the generals. Experiments were performed to calculate the power savings, resulted in about 50 per cent power savings were achieved. The proponents concluded that, on the basis of identification and fair decision and operational standards, the system configuration consisted of introducing sleep modes to reduce the power usage of the proposed system. The proponent conducted a survey sample consists of a group of 30 people with varying level of strategies in playing the Game of the Generals whose age from 18 to 40 years old. Based on the statistical treatment applied in the datasets collected, the average time to spent to complete the game is 24.97 with a frequency of 28. And with a standard deviation (8.98). This resulted to a negative skew. For the number of times that the device turns into idle time, the average is 8.2 with a frequency of 11 and the 50th percentile of 10. The standard deviation of (5.28) from the normal of 8.2. The proponents concluded that the greater the number of times that the device turn into idle time or sleep mode the higher the power savings.

Key words: Low-powered game of the general, Sleep mode, watch dog timer

1. INTRODUCTION

The progress of technology leads to innovate board games to automate by using digital technology and wireless technology such as RFID technology in which used in the various fields of technology and business, such as logistics, security, anti-theft systems, banking, Internet of Things and many others [1-2]. Various forms of recreational board games were introduced to ease the stress of people of today. Board games has been used in different field like cognitive science [3] and also in areas in medicine [4]. Board games were introduced and played during the 19th century by people and the very same time when the Game of the Generals was released.

1.1 Game of the Generals Board game

Board games were introduced and played by people during the 19th century and the very same time when the Game of the Generals was released. The "GG" (coined for Games of the Generals) was invented by Sofronio H. Pasola Jr., a Filipino in 1970. Now a days the Game of the Generals is popularly known as "Salpakan" in Filipino (literally means Battle fight) is a strategic war games which aim to capture the flag of the opponent or conquered its base. The first who will get the flag is the winner. This game is basically designed for two players and an arbiter who decides what piece wins on the game. Nowadays, Game of the Generals invaded the world's game market. The GG game fanatics organized events for competitions joined by GG players of different race around the globe, especially online Game of the Generals. The increasing popularity of this game, GG gamers thinking of integrating technology for this noble game originated from the Philippines. Detection of Rank for every piece is one area of innovation using the RFID technology. RFID technology application scattered in different fields such as electronic and communication, auto control, computer science and networking technology. The RFID's capability of ensuring accurate, real- time information leads to makes a difference in GG's Playability. Basically, the Game of the Generals requires the presence of an arbiter to decide who wins in every round of the game. Generally, the problem involves the presence of an arbiter which is traditionally a third person invited by the two players to watch their play and score their moves in every round of the game. One cannot deny the fact that the traditional arbiter could be biased in making decisions. The proponents identified the specific problems occurs in playing the Games of the General concerned that how to design and implement an electronic arbiter utilizing the RFID technology in the real game.

1.2 Game Rules

This game was played in 20-30 minutes. This game was consists of two (2) players, an arbiter or adjutant. Each players or team controlled an army. Logic and strategy were one of important factor to win the game. This game imitates armies attempting to flee and overpower one another. Strategy will lead to one team to succeed. Nonetheless, other techniques and methods help both sides to get a clearer understanding of the strategy of the other player as the game progresses. During tournaments, players will even speak to someone, trying to give a mistaken assumption of where the flag is. One needs to learn some simple words such as arbiter, pieces, block, offensive side and defensive side if we want to play Game of Generals.

Arbiter: The third person who judges the rank of each battle round participate the game.
Pieces: The players campaign's set composed of 42 pieces, 21 pieces for each play side.
Block: One of the 72 square wailablepositions on the board.
Offensive side: Game of Generals is designed for two players when game starts first move side that we call it offensive side.
Defensive side: Game of Generals is designed for two players when game starts second move side that we call it offensive side.

The game aims at destroying or catching the opponent's flag, by maneuvering one's flag to the other end of the row. The player's set of pieces or soldiers with the corresponding roles and functions comprises of the 21 pieces that follow. A higher ranking piece would replace every lower ranking piece except the spy, removing all pieces but the private piece. The pieces are bent at an angle to conceal the opponent's rank or insignia on the object. Apart from the flag (the Philippine flag) and the spy (a pair of prying eyes), the insignias used in the game are those used in the Philippine Army.

Table 1: Game of the Generals' Pieces and Ranks

Pieces	No. of Pieces	Function
Five-star General	1	Eliminates any lower ranking officer, the private, and the flag.
Four-star General	1	Eliminates any lower ranking officer, the private, and the flag.
Three-star General	1	Eliminates any lower ranking officer, the private, and the flag.
Two-star General	1	Eliminates any lower ranking officer, the private, and the flag.
One-star General	1	Eliminates any lower ranking officer, the private, and the flag.
Colonel	1	Eliminates any lower ranking officer, the private, and the flag.
Lt. Colonel	1	Eliminates any lower ranking officer, the private, and the flag.
Major	1	Eliminates any lower ranking officer, the private, and the flag.
Captain	1	Eliminates any lower ranking officer, the private, and the flag.
1st Lieutenant	1	Eliminates any lower ranking officer, the private, and the flag.
2nd Lieutenant	1	Eliminates the sergeant, the private, and the flag.
Sergeant	1	Eliminates the private, and the flag.
Private	6	Eliminates the spy, and the flag.
Spy	2	Eliminates all officers from the rank of Sergeant up to 5-Star General & the flag.
Flag	1	Eliminates the opposing flag as long as it takes the aggressive action against the enemy flag

Regardless of who initiated the challenge, their ranks determine which one is to be removed.

1. Any one of the player's pieces can capture the opposing flag. This includes the player's own flag.
2. Any piece eliminates the private except the spy and the flag.
3. Officers eliminate other officers that are ranked below it (e.g. a four-star general eliminates a lieutenant-colonel).
4. A spy eliminates all officers (including the five-star general). Only the private can eliminate the spy.
5. If both pieces are of the same rank, both are removed from the board.
6. If a flag reaches the opposite end of the board, the opponent has one turn left although it is not announced. After the turn, the player reveals the flag. If the flag was not challenged, the player wins the game. If it was challenged, the player loses.

2. METHODOLOGY

The development of the proposed system was divided into three parts the hardware development procedures, experimental procedures and Development of low power algorithm.

2.1 System Architecture

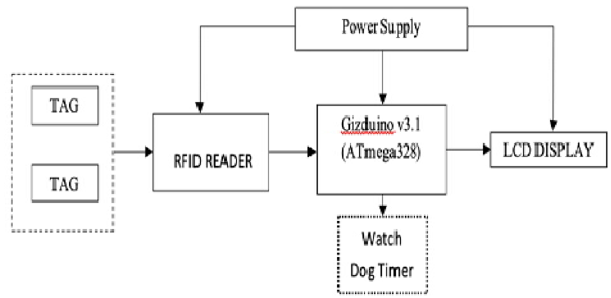

Figure 1: Block Diagram of a Low powered Game of the General

Figure 1 shows the overall system architecture of the actual board game. Basically the system comprises of the Gizduino v3.1 (ATMEGA 328) microcontroller where the watch dog timer will be activated to enter into a sleep mode when the system was not in used for a long period of time, The system consist of RFID reader and tags, LCD Display and a 6V battery. The GG pieces made of card tags with different ranks will serve as the input. The microcontroller receives the gathered data from the RFID reader. The microcontroller converts the signals to serial data through its built in converter. Once, the data is converted and then processed in the microcontroller and send the data to the LCD display to show the status of the data gathered and give information to the next player that it is his turn to tap his piece. the microcontroller that have been used in this study is Arduino where Arduino has been used in different studies such as in knock pattern using a piezo electric effect [5], to controlled electric fan using a gesture [6] robotics learning program[7] rice straw decomposition [8] and even in irrigation[9].When the MCU received the second data from the RFID reader and undergone the same process with the first data, the MCU compare the rank of the two data received and display to the LCD who wins and display the remaining pieces of both players. It also display the status if both pieces dies or draw or which team win on the face-off.

.

2.2 Procedures in Developing the hardware

The development and completion process for the Hardware Unit of the system encompasses the following:

(a) The card tags were used as the Games of the Generals pieces.

(b) The RDM 630 RFID reader is place on the front side of the GG box where the players can tap their pieces made of RFID card tags.
(c) The LCD Display was installed on the top of the GG box device
(d) The LCD utilize the pin 12, 11, 6, 5, 4, 3 and connected to RS, Enabled, D4, D5 & D6 of the Arduino module.
(e) The RDM630 RFID reader will be connected to the guizduino module. The TX pin of the RDM630 RFID reader is connected to the RX (pin 0) of the Arduino, the +5V pin of the RDM630 is connected to the +5V of the Arduino and the GND is connected to the GND of the Guizduino v3.1 (Atmega 328) microcontroller.

2.3 Experimental Procedures

The proponents utilized the following tools to measure the power savings. Measurement of signals in the form of a varying electrical voltage can be displayed either by an oscilloscope or by any of the electrical meters[10]. Oscilloscope which was recognized as one of the key tools for the analysis of electrical signals. The key information gained from the waveform of the signal is the visualization of its change in amplitude over time. [11].

A. Ammeter

The proponents first measure the individual current of the peripherals attached to the microcontroller such as the current generated in LCD and RFID.Then the current for the whole system was also measured during normal operation and during the sleep mode.

Table 2: Whole system Normal Operation vs. sleep mode Current

No. of Readings	*Active Current (Icc)*	*Sleep Current (Icc)*	*Difference (△Icc)*
1	78mA	40mA	38mA
2	76mA	43mA	33mA
3	110mA	52mA	58mA
4	120mA	55mA	65mA
5	127mA	58mA	69mA
6	130mA	60mA	60mA

Table 3: Normal Operation vs. sleep mode Current of attached devices

NO. OF READINGS	LIGHT EMITTING DIODE	BACKLIGHT	LCD DISPLAY	RFID READER
1	85mA	28.3mA	9.10mA	28.2mA
2	85mA	28.4mA	9.3mA	28.4mA
3	85mA	28.6mA	9.5mA	28.7mA
4	85mA	28.7mA	9.6mA	28.8mA
5	85mA	28.8mA	9.7mA	28.9mA
6	85mA	30mA	10mA	30mA

Table 2 shows the current measured during the normal operation of the whole system vs. the current of the whole system without the sleep mode features. In the series readings conducted, the proponent measured the current starting at 78mA (Icc) and with a peak of 130mA for the normal operation. For the current measured in the whole system with the implementation of sleep mode, the current measured is lesser 60mA only. To determine what devices consumed a lot of power the proponent measured the individual current of the LCD display with the backlight and the LCD display current without the backlight. The current measured in LCD with backlight is higher than without the backlight. The RFID reader had a current of 30mA (peak). The peripherals that has the highest current is the LED (indicator) in the mcu, it has a current of 85mA. The proponent keenly observed that the current is high during normal operation. The device saves almost 50% of the power consumed.

B. Oscilloscope

1. In order to see in full details, what is going on with all the Frequency, voltages and current of the proposed system. The proponent uses an oscilloscope to measure first the clock signals coming from the Microcontroller during normal operation and during sleep mode.

2. Initially, the proponent measures the frequency of the RFID tag using a network analyzer in the reflection mode. Measurement conditions (case of short-range RFID tag): start frequency: 10 MHz End frequency: 15 MHz, power: –10 dB (which is the minimum level of detection, the lowest field required to power the chip) The coil must be in the field generated by the network analyzer by the loop probe.

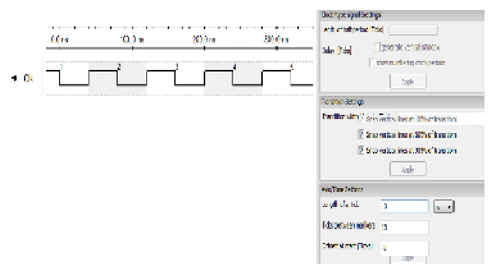

Figure 2: Timing Diagram during normal operation

2.4 Low Power Algorithm Development

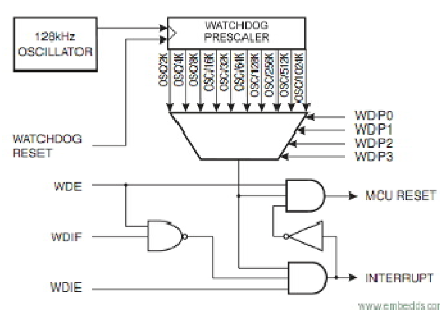

Figure 3: Watch dog Timer Logical Diagram

Figure 3 shows watch dog Diagram where it shows a basic counter that gives the pulse to count. This pulse may either be used to produce an interrupt or actually reset the MCU (or do both).Watchdog timer can be set back to zero at any time with a simple WDR command. If the watchdog timer has been activated, it will reset it until it fills and resets the MCU.

Watch dog timer when enabled through programming languages will resulted to low power consumption.
Otherwise, whether the program hangs or stays in some infinite loop without reset watchdog, it simply counts and resets the system.

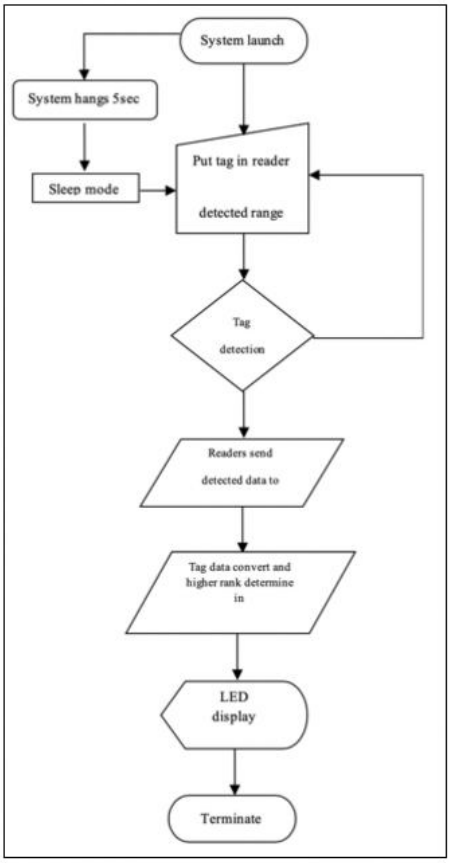

Figure 4: Flowchart of the system with sleep mode features

Figure 4 shows the system flowchart with the sleep mode features. Once turned on the system it will display system ready and will accept tags to be read. Once tag detected sends data to mcu and determined its rank, then display the rank detected, next will wait for the pieces tag of the opponent, once detected send data to mcu and convert it then identified the rank and display the rank on the LCD. The system will determine whose team has the highest rank and display whose team got the highest rank. In the advent that the system hangs for 5 second it will enter into sleep mode.

Pseudocode

Initialization

successful tag detection to zero
failed tag detection to zerotag initializes
If system idle for 30 secs the system will enter sleep mode
Else
Continue process
If tag is successfully detected send signal to mcu
Print LCD " TEAM READY, NEXT TEAM TURN"
print. LCD "Red counter / Blue counter"
Else
Return;
// convert tagged data into rank and compare the data ranks and determine the higher rank
print. LCD "Red/Blue Team Wins

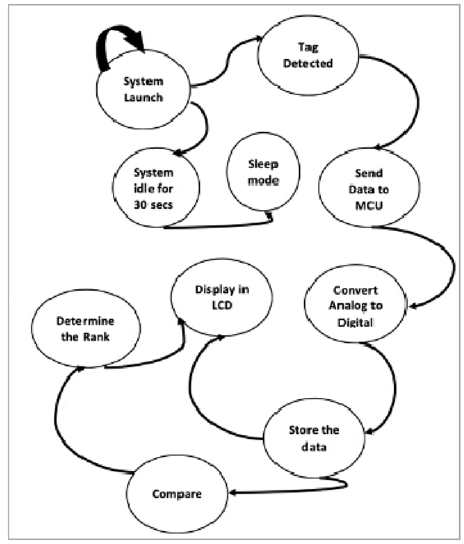

Figure 5: State Diagram of the System

Figure 5 shows the state diagram of the system, each state or phase of the system were presented. Starts from system launch , Tag detection, sending the data to the Arduino, convert the analog signals to digital, Store the data and display the rank in LCD, Compare with the piece of the opponent and then compare whose piece has the highest rank. The winner team will be displayed in the LCD.

2.5 Data Collection

The sample consists of a group of 30 people with varying level of strategies in playing the Game of the Generals whose age from 18 to 40 years old as shown in table 3. The subject plays the GG device and performs their strategies in playing the game. While the subjects are playing the proponent recorded the time they completed the game and the number of idle time of the device. Every 30 seconds that the RFID tag is not in use the device turn into sleep mode. The proponent used independent observations where the errors in the observations are independent of each other. The proponent calculated for the mean, median, sample variance and the sample deviation and the sample error.

To get the mean or the average the proponent used the formula:

$$\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n}$$

and for the variance, the formula below was used to get the difference from each sample

$$s^2 = \frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n-1}$$

For the standard deviation, it is the square root of the variance. The proponent calculated also the skewness of the data was gathered to determine the shape of its distribution.

Table 4: Datasets

Sample (N)	*Opening game* Time Completed the game (mins)	*Number of moves* RED	BLUE	No. of Idle time (mins)	*Middle game* *Number of moves* RED	BLUE	Number of idle time	*End game* *Number of moves* RED	BLUE	Number of idle time	*Calculated Power consumption without sleep mode (mW)*	*Power consumption with sleep mode (mW)*	*Power Savings (mW)*
1	12	6	7	0	9	8	0	4	4	0	7176	0	0
2	10	10	4	0	8	9	0	5	4	0	5980	0	0
3	14	10	4	0	10	7	0	4	5	1	8372	8312	60
4	28	5	9	4	15	2	2	4	5	5	16744	16084	660
5	30	8	6	0	2	15	3	2	7	9	17940	17220	720
6	31	5	9	2	6	11	2	6	3	9	18538	17758	780
7	26	8	5	3	10	7	0	4	5	3	15548	15188	360
8	15	5	9	0	11	6	1	2	7	2	8970	8790	180
9	25	3	11	1	7	10	2	4	5	7	14950	14350	600
10	32	2	12	1	6	11	5	3	6	8	19136	18296	840
11	20	12	2	0	7	10	2	6	3	1	11960	11780	180
12	22	11	2	1	6	11	1	2	7	2	13156	12916	240
13	18	5	9	0	7	10	2	3	6	2	10764	10524	240
14	17	8	6	0	4	13	1	1	8	1	10166	10046	120
15	10	6	8	0	6	11	0	4	5	2	5980	5860	120
16	12	6	8	0	9	8	0	4	2	2	7176	7056	120
17	14	5	9	0	9	8	0	6	1	1	8372	8312	60
18	30	6	8	1	6	11	5	3	3	5	17940	17280	660
19	35	5	9	1	2	15	4	2	5	7	20930	20210	720
20	32	2	12	1	11	6	2	7	1	8	19136	18476	660
21	28	7	7	0	2	16	3	4	3	7	16744	16144	600
22	25	12	2	1	2	15	2	2	5	6	14950	14410	540
23	38	8	6	0	1	16	4	3	4	11	22724	21824	900
24	40	6	8	1	7	10	4	6	2	12	23920	22900	1020
25	35	5	9	1	6	11	3	7	2	10	20950	20090	840
26	28	9	5	2	8	9	4	7	3	6	16744	16024	720
27	30	8	6	1	7	10	4	4	5	8	17940	17160	780
28	27	7	7	0	8	9	3	6	3	7	16146	15546	600
29	25	8	6	1	11	6	3	6	3	5	14950	14410	540
30	40	5	9	2	4	13	4	4	5	9	23920	23020	900

3. EVALUATION AND RESULTS

A. *Normal Operation Current vs. Sleep Current Results using ammeter*

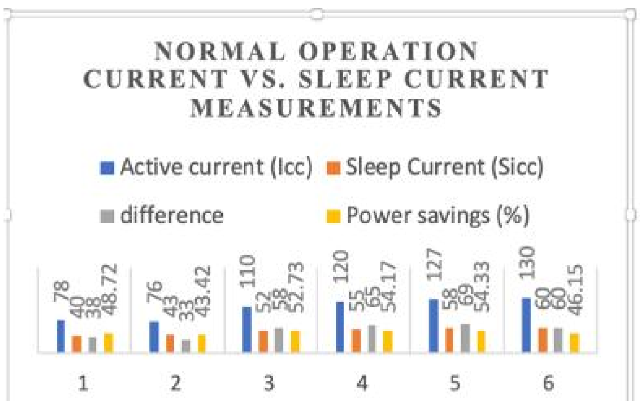

Figure 6: Normal operation vs. sleep current results

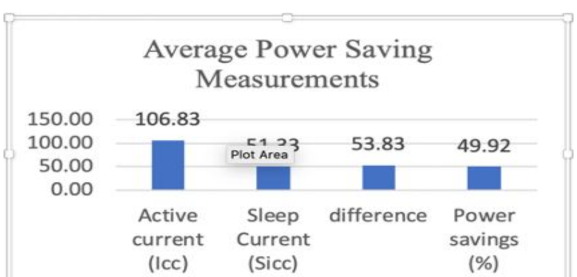

Figure 7: Average Power Savings

Figure 6-7 shows the graph of current measured during the normal operation of the whole system vs. the current of the whole system without the sleep mode features. In the series readings conducted, the proponent measured the current starting at 78mA (Icc) and with a peak of 130mA for the normal operation. For the current measured in the whole system with the implementation of sleep mode, the current measured is lesser 60mA only. The graph shows that there is 49.92% of power saving when sleep mode was applied in the system.

B. *Oscilloscope reading results*

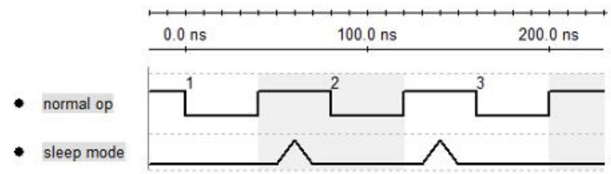

Figure 8: Timing diagram of Normal operation vs. Sleep mode

Figure 8 shows that during sleep mode operations the system does not totally shuts down. There are active peripherals connected. The MCU turn into Power Save mode only where everything is turned off except a 32 kHz clock running from a crystal to keep track of time. Idle mode is a shallow sleep mode where only parts of the device are shut down but the main parts of the microcontroller are running.

Table 5: Power consumption without sleep vs. Power consumption in sleep mode

Column1	Time Completed the game	Total Number of idle time	Power consumption without sleep mode (mW)	Power Consumption in sleep mode. (mW)	Power savings (mW)
Mean	24.97	8.2	14930.07	13999.53	492
Mode	28	11	16744	0	660
Median	26.5	10	15847	15367	600
Variance	80.59	27.89	28817538.89	35538239	100402.76
Standard Deviation	8.98	5.28	5368.2	5961.4	316.86
Skewness	-0.17	-0.21	-0.16676574	-0.740826	-0.2090819

Table 5 shows the tabulation of data gathered from the 30 samples (n-1) , to determine the average of time spent to complete the game , the number of times that the device turn into sleep mode, the power consumption calculated without sleep mode application , the power consumption during sleep mode and the power savings. The average time to spent to complete the game is 24.97 with a frequency of 28. And with a standard deviation (8.98) or how far it is from the normal. The result has a negative skew. For the number of times that the device turns into idle time, the average is 8.2 with a frequency of 11 and the 50th percentile of 10. The standard deviation of (5.28) from the normal of 8.2. The proponent notice that the more the number of times that the device turn into idle time or sleep mode the higher the power savings.

4.CONCLUSION AND FUTURE WORKS

The proponents proposed a low powered game of the generals' pieces ranking detection to developed. The system provides improved performance on deciding whose piece wins in face-off of both team and to display the status of every piece tapped on the device and also display whose piece win in every game. The implementation of the system with an RFID technology is contributed to provide data about whose piece have been ready and tapped and whose piece turned next, whose piece wins in their encounter and the remaining pieces left. It was also concluded that based on detection and fair decision function and operating principle, the system structure was consisted mainly four parts such as (i) detection of piece through RFID tag, (ii) intelligent device equipped with RFID reader and gizduino microcontroller that compares the ranks and decides whose piece wins, (iii) Display platform interfaced with LCD display that shows transparency in showing the status of both teams (IV) implementing sleep modes to lowered the power consumption of the device respectively. In this section, RFID tag and Reader data acquisition using RFID and communication technologies to detect the pieces and transmit the data to the microcontroller for the microcontroller to processed the data gathered. The proponent also concluded that the greater number of times the device turns into sleep modes the lower the power consumptions of the device. For Future work the proponents will be using mathematical models such as wave propagation model and FEM modelling.

ACKNOWLEDGEMENT

The proponents would like to thank the MR. SUAVE Laboratory at Computer Engineering Department of Technological Institute of the Philippines-Manila for the computing facilities.

REFERENCES

1. R. Want. **An Introduction to RFID Technology** IEEE*Pervasive Computing,*Vol. 5, pp. 25-33, 2016. https://doi.org/10.1109/MPRV.2006.2
2. A. Juels.**RFID Security and Privacy:A Research Survey**, *IEEE Journal on Selected Areas in Communication* , vol. 24 , pp. 381-394, 2016.
3. B. Taspinar, W. Schmidt, H. Schuhbauer. **Gamification in Education: A Board Game Approach to Knowledge Acquisition.,***Procedia Computer Science., 99 International Conference on Knowledge Management, ICKM 2016,*pp.101-116, October 10-11, 2016. https://doi.org/10.1016/j.procs.2016.09.104
4. M. Kordaki, A. Gousiou. **Digital card games in education: A ten year systematic review.**Computers and Education, vol.109, pp.122-161, 2017.
5. A.S.Alon, C.D.Casuat, J.N.Mindoro, M.A.F. Malbog. SmaCK: Smart Knock Security Drawer Based on Knock -Pattern Using Piezo-Electric Effect. International Journalof Emerging Technologies in Engineering Research(IJETER) ,vol.8,No.2, February 2020. https://doi.org/10.30534/ijeter/2020/16822020
6. A.S. Alon, J.B. Susa.Wireless Hand Gesture Recognition for an Automatic Fan Speed Control System: Rule-Based Approach. 2020 16th IEEE International Colloquium on Signal Processing & Its Applications (CSPA), April 17, 2020.
7. G. Wang, H. Kristian, P. Weniko. **Gamification for Better Patient Experience in Queue at the Hospital.** *International Journal of Advanced Trends in Computer Science and Engineering (IJATCSE)*, vol.9, pp. 477-479, 2020. https://doi.org/10.30534/ijatcse/2020/65912020
8. C.D. Casuat, A.S. Alon, J.N. Mindoro, M.AF. Malbog, J.A.B. Susa.**Biofuz: A takagiSugeno Fuzzy Expert-Based Rice Straw Enhanced Decomposition System**,*International Journal of Advanced Trends in Computer Science and Engineering (IJATCSE),*2020. https://doi.org/10.30534/ijatcse/2020/192922020
9. M.A.F. Malbog, J.A.B Susa,, A.S.Alon, C.D.Casuat, J.N.Mindoro.**A Fuzzy Rule- Based Approach for Automatic Irrigation System Through Controlled Soil Moisture.** *International Journal of Advanced Trends in Computer Science and Engineering (IJATCSE)*, 2020. https://doi.org/10.30534/ijatcse/2020/216922020
10. A.S.Morris, R. Langari," **Measurement and Instrumentation"**, *Science Direct*, 2012.
J.M.D. Pereira, "**The history and technology of oscilloscopes"**, *Instrumentation & Measurement Magazine, IEEE*, Volume 9, Issue 6, 2006 Page(s):27 – 35. https://doi.org/10.1109/MIM.2006.250640