PRIMARY RESEARCH

Wireless sensor network development: Targeting and control system for semi-ballistic vehicle for rapid and precise search and rescue applications

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Abstract

This paper considers the vast development in sensor technology such as embedded systems, GPS, wireless communications, and wireless sensor applications. In recent years an efficient design of a Wireless Sensor Network has become a leading area of research for semi-ballistic uncrewed Aerial Vehicle (UAV). A sensor network is a device that responds and detects some type of input from both the physical or environmental conditions, such as pressure, heat, light, etc. The sensor's output is generally an electrical condition that is transmitted to the controller for further processing. Wireless sensor network has been widely used. Its design has become an important field of control engineering and provides a real-time communication system in surveillance, tracking, and monitoring applications. In this paper, the development of a wireless sensor network for targeting and control system of a semi-ballistic UAV for rapid and precise search and rescue operations is being presented and discussed. The developed system is composed of two sections: Air Section and Ground Section. The Air Section consists of Magnetic Compass Sensor, Micro-Electro-Mechanical Sensors (MEMs), GPS, Camera, Servo Motor, and Parachute Controllers. The latter consists of Video Recording, Receiver, and Monitoring. The system will help in locating the exact location at the centralized level. In effect, it increases the response efficiency. Furthermore, this system helps control and protect the naval, ground and arm forces in any search and rescue operation locations. The wireless sensor network system can collect, store, and analyze data from several devices embedded in the vehicle. Results show that multi-sensor fusion and integration play a critical role in the semi-ballistic uncrewed aerial vehicle's overall design and performance enhancement.

I. INTRODUCTION

A. Background of the Study

The development of Wireless Sensor Networks (WSN) was motivated in naval applications such as UAV which is a type of aircraft that operates without a human pilot onboard is used in monitoring aerial images and surveying objects and grounds on the basis of Orthographic photos. In this study, the design of a UAV is used for the utilization of UAV's intelligence system for providing real-time communication system in surveillance, tracking, and monitoring applications. In recent years an efficient design of a WSN has become a leading area of research in semi-ballistic unmanned vehicle.

A network of sensor is a device that responds and detects some type of input from both the physical or environmental conditions, such as pressure, heat, light, etc. The output of the sensor is generally an electrical conditions that is transmitted to controller for further processing [1, 2, 3].

The WSN is composed of two sections: Air Section and Ground Section. The Air Section consists of Magnetic Compass Sensor, MEMs, GPS, Camera, Servo Motor and Parachute Controllers and the latter is consist of Video Recording, Receiver and Monitoring.

The development system is capable of collecting, storing, and analyzing the data from several devices embedded in

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the UAV. Furthermore, this system helps in controlling and protecting naval, ground and arm forces in any location for the search and rescue operations.

B.　Statement of the Problem

Historical evidences from naval artillery originally used for naval warfare is considered a serious matter that need to be addressed. This study would like to design and fabricate a UAV with a technology of sensor for a wireless communication and a wireless sensor applications. The design system of UAV can be used for intelligence system for a real-time communication system in surveillance, tracking, monitoring and a rescue applications.

C.　Objectives of the Study

The study aims to design and develop the WSN for Targeting and Control System of Semi-Ballistic Vehicle for Rapid and Precise Search and Rescue Operations. The following are the specific objectives:

1. To create compact architectural design for the proposed semi-ballistic vehicle system.
2. To design and implement WSN for localization, target identification, guidance and control using fins and release mechanism for steering at different angle of inclination.
3. To determine the efficacy of the system through actual field test.

D.　Significance of the Study

In today's military, unmanned systems are highly desired combatant commanders for their versatility and persistence. The common tasks such as surveillance; signals intelligence; precision target designation; mine detection; and chemical, biological, radiological, nuclear reconnaissance, unmanned systems have made key contributions.

With the development of a WSN is an efficient and cost effective design target and control system for UAV for rapid and precise search and rescue operations, which is intended precisely hit a specific target and to minimize collateral damage.

E.　Scope and Limitations of the Study

This study aims to develop the following are the scope and limitations of the WSN for Targeting and Control System of Semi-Ballistic Vehicle for Rapid and Precise Search and Rescue Operations.

1. Using a water rocket and a water rocket launcher in which the angle of inclination varies.
2. To use colored flags as target.

II.　REVIEW OF RELATED LITERATURE

A.　Historical Review

1)　Water-propelled rocket: An experimental study: The study of rocket motion has been merely used for decades with the combination of the use of electronic computers which triggers the problem of analyzing the motion of an air-pumped, water propelled rocket. Moreover, the purpose of conducting such study was to determine the optimum amount of water to be put into the rocket in order to accurately achieve the maximum possible apogee. Through using this analysis, it can be applied to the popular demonstration using a 2-*l* soda bottles pressurized by a bicycle pump [4].

2)　Thrust: The thrust, T, of a rocket due to the ejection of mass from the nozzle is

$$T = \left| v_e \frac{dM}{dt} \right| \qquad (1)$$

where v_e of equation 1 is the exhaust velocity of the ejected mass in the rocket's frame of reference and $\frac{dM}{dt}$ is the rate at which mass is ejected from the rocket. In this case, the mass is the water that is pushed out as a result of the elevated air pressure inside the rocket. Because v_e and $\frac{dM}{dt}$ both defend on the pressure inside the rocket, finding the time profile of the thrust is nontrivial.

Bernoulli's equation states that the conservation of energy is applied at two points along a streamline. This can be written generally as

$$P_1 + \tfrac{1}{2}\rho v_1^2 + \rho g y_1 = P_2 + \\ \tfrac{1}{2}\rho v_2^2 + \rho g y_2 \qquad (2)$$

Figure 1 shows a schematic diagram of the rocket. As shown, take point 1 as the surface of the water inside the rocket and point 2 just outside the nozzle. Neglecting the pressure difference due to the height of the water and neglecting the velocity of the water at the surface compared to the velocity at the nozzle and obtain the equation as

$$P = P_a + \frac{1}{2}\rho_w v_e^2 \qquad (3)$$

where P is the pressure inside the rocket, P_a is atmospheric pressure, and ρ_w is the density of water. Equation 2 can solved for v_e and determines the exhaust velocity as a function of internal pressure P to find the thrust from Equation 2 is the mass flow rate times the density of the water,

$$\frac{dM}{dt} = \rho_w \frac{dV}{dt} = \rho_w A_e v_e \qquad (4)$$

where A_e from Equation 4 is the cross-sectional area of the exhaust nozzle. Combining Equations 2- 4 gives:

$$T = 2\left(P - P_a\right) A_e \qquad (5)$$

Figure 1 shows on how to find the thrust therefore, depends on finding the pressure within the rocket as a function of time. As the rocket eject the water, the pressure and exhaust velocity drop and thus the rate of pressure decrease drops. The solution begins with two following assumptions: (1) the air in the rocket behaves as an ideal gas and (2) the air expands isothermally. These assumptions allow us to write:
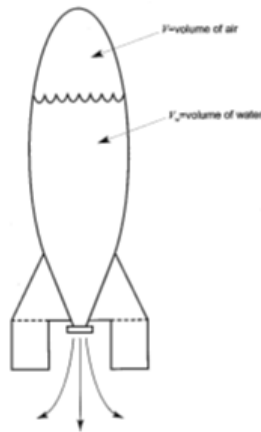
$$PV = P_o V_o \qquad (6)$$

Fig. 1. Sketch of the water rocket under consideration

where P and V are the pressure and volume of air inside the rocket at any time before all the water is ejected and P_0 and V_0 are the initial pressure and volume of air. In solving for P and taking the derivative with respect to time

$$\frac{dP}{dt} = -\frac{p^2}{P_0 V_0} A_e \frac{dV}{dt} \qquad (7)$$

Now substituting from Equation 3, 4 and 6, to eliminate *V*, we get

$$\frac{dP}{dt} = -\frac{p^2}{P_0 V_0} A_e \sqrt{\frac{2\left(P - P_a\right)}{\rho_W}} \qquad (8)$$

Equation 8 can be solved to obtain *P(t)*. the analytic solution is presented below for comparison but, because of the complexity of the result in order to utilize the numerical solution for *P(t)*.

3) Launching: The launching of rockets several times is considered in order to compare the results of their model to the actual performance of their rockets. The height was estimated in two ways. First, by using the triangulation, but the available equipment (protractors and plumb bobs) yielded less than satisfactory results because the uncertainty in the height was too large. The second technique is to measure the total time of flight for the rockets and to estimate the maximum height.

B. Inertial Sensor Technology Trends

This paper presents an overview of how inertial sensor technology is applied in current, near and far-term applications. It also discuss the ongoing trends in inertial sensor technology development, namely interferometric fiber-optic gyros, micro-mechanical gyros and accelerometers, and micro-optical sensors. The micromechanical sensors and improved fiber-optic gyros are expected to replace many of the current systems using ring laser gyroscopes or mechanical sensors. It also presented the successful introduction of the new technologies is primarily driven by cost and cost projections for systems using these new technologies are presented. Externally aiding the Inertial Navigation System (INS) with the GPS has opened up the ability to navigate a wide variety of new large-volume applications, such as guided artillery shells. These new applications are driving the need for extremely low-cost, batch-producible sensors [5, 6, 7].

C. GPS Localization Improvement of Smartphones Using Built-in Sensors

In using smart and android phones its navigation and location awareness now become some of the crucial features. Individual navigation and location based administrations are expanding the extent of versatile applications. GPS is the most proficient situating innovation. On account of the decrease in the span of the GPS beneficiaries and the coordination of GPS with cell phones, GPS is a standout amongst the most essential specialist organizations in LBS. in line with this, since smart and mobile phones more often than not have moderately minimal effort GPS chips, the execution of finding precision is exceptionally subject to natural elements. Likewise, the exactness of GPS shift relying upon the quantity of GPS satellites and is lessened in GPS meddling spots, for example, in a timberland or around structures. This paper proposes a confinement enhancement calculation in GPS meddling spots by incorporating data of numerous sensors in cell phones. The proposed calculation is executed in a cell phone and the execution is assessed on a grounds. The proposed calculation has preferable execution over just the GPS area data in GPS meddling spots and keeps up sensible execution in open spaces where the GPS beneficiary is precise [8].

The decrease in the measure of GPS beneficiaries and the joining of GPS with mobile phones have made location based administration application better known. There have been many contextual analyses of area based administrations utilizing cell phones and cell phones with GPS. An

application examine on a taxi calling and dispatching framework is proposed in [8]. This is a model of a LBS application dependent on GPS cell phones. It gives the fundamental plan, modules division, GIS show calculation configuration, test results and highlight examination of the proposed framework. Another portable application dependent on giving LBS utilizing GPS as a location provider is to find relatives when companions are close-by [9]. The applications work in open space territories just since it depends on GPS. A disseminated direction comparability seek system is presented in [10]. It centers on GPS trace search in mobile phone networks by decentralized and in-situ information.
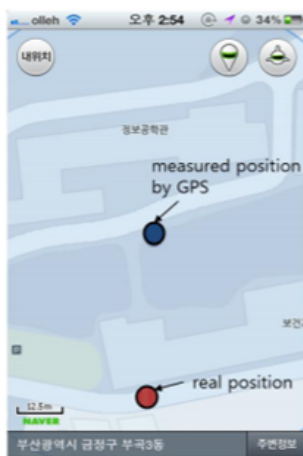
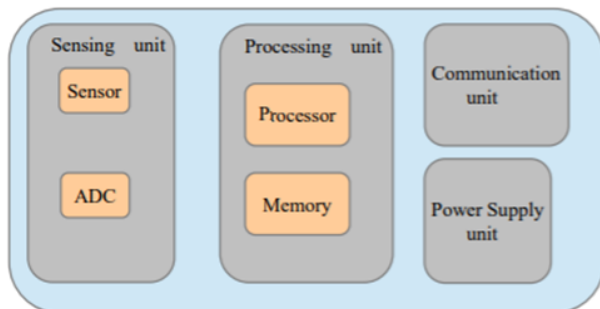Fig. 2. Positioning error in GPS interfering spot

Fig. 3. Traditional sensor node

[11] gives another strategy for exact Wi-Fi AP confinement utilizing GPS data of cell phones and the got flag quality (RSS) data from Wi-Fi APs. Since GPS is the most effective situating innovation, most portable LBS applications use GPS as an area supplier. Be that as it may, as made reference to before cell phones and cell phones have moderately minimal effort GPS chips, in this way the execution of finding exactness is exceptionally subject to natural factors, for example, climate or GPS meddling territories. To expand the use of such different portable LBS applications, it is crit-

ical to enhance GPS exactness. Figure 2 indicates GPS situating mistake in a cell phone when the client is close elevated structures. So we considered about an investigation to surpass this GPS error.

D.   Camera-Based WSN for E-Health

WSN are generally connected in numerous fields, for example, e-health, military, observation and mechanical applications. In e-health field, WSN is regularly utilized for checking elderly individuals, babies, and patients The advancement of WSN advances enabled the association of a camera to WSN hub to exchange pictures and video. This innovation enhances the observing of patients and gives more data which isn't accessible with customary WSN hubs. The issue with picture and video transmission is the appeal of transfer speed and the necessities of human checking at the server side. In this exploration, pictures caught by WSN hubs are investigated at the hub side and just uncommon pictures are exchanged showing unique patient exercises. This diminishes the required transmission capacity and decrease the human exertion the server side. Picture preparing calculation are upgraded to be appropriate for the low calculation power and memory assets in the WSN camera hub.

A traditional sensor node as shown in Figure 3 is predominantly made out of four units, sensor unit, preparing unit, remote correspondence unit and power supply unit.

Some other discretionary units can be found in sensor hubs. In camera sensor hub in Figure 4 shows the sensor unit supplanted with a picture procurement framework. Figure 3 and 4 demonstrates the designs of a customary sensor hub and camera sensor hub.
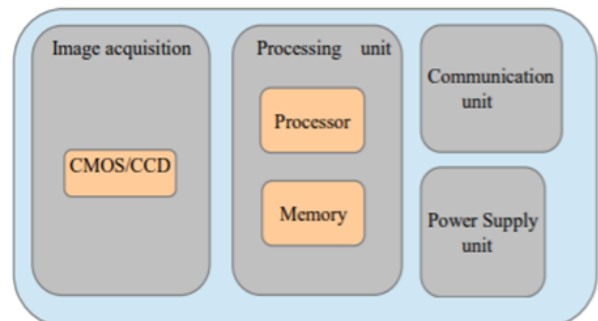

Fig. 4. Camera sensor node

While the two structures are by all accounts comparative, yet there are numerous enormous contrasts between the two sensors. The employed sensors, for example, temperature and weight sensors, regularly create a constrained measure of information at very low rates. Along these lines,

there is no requirement for high handling capacities inside the hub and an ultra-low-control gadget can control the whole procedure (including procurement, preparing and remote correspondence) [12].
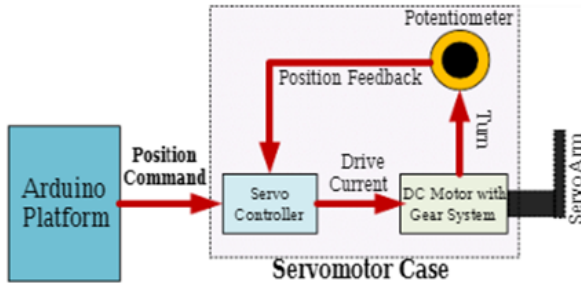

Fig. 5. The block diagram of an open-loop DC servo motor with "internal" voltage feedback

E. A Comparative Study on the Position Control Method of DC Servo Motor with Position Feedback by using Arduino

In contrast to Direct Current (DC) motors, the DC servo engine's rakish position can be acclimated to a particular point by utilizing a control flag. Arduino has as of the late been utilized in an extensive variety of control approaches, particularly including shut circle framework with servo engine because of its adaptability and effortlessness. With the end goal to control the DC servo engine, there are three distinct techniques that can be utilized by utilizing Arduino to be specific Arduino Integrated Drive Electronics (IDE), Support focus for Simulink (Support Package) and Arduino Input/Output (IO). This paper displays a similar report on the servo engine position control (with voltage input) by utilizing the above strategies to discover the best strategy to control the perplexing servo engine framework with closed-loop position feedback [13].

1)   Open-loop and closed-loop DC servo motor: An open-loop DC servo motor comprises of a framework that has no input reference amid the engine task [14]. Consequently, the framework has no component to decide mistakes or to confirm whether the framework is executing obviously. On account of open-circle DC servo engine, there is no criticism reference that turns out from the servo engine when associated with an outside controller. In any case, this sort of servo engine isn't actually an open-circle servo engine. It has an "inward criticism" component that gives the position input to the servo inside the engine. The position criticism originates from the potentiometer that is associated with the servo rigging component. The potentiometer perusing is then changed over to a voltage where the qualities are corresponding to the situation of the servo shaft. In any case, the downside of the "interior feedback" highlights is that it just gives position criticism to the servo controller which is situated inside the engine case [15]. The block diagram of an open-circle DC servo motor with "Interior" voltage input is illustrated in Figure 5 [16].

In contrast, a closed-loop DC servo engine comprises of a framework that works while having a criticism instrument for a framework to confirm the coveted and real state of the yield. On account of DC servo engine, having a shut circle criticism is a noteworthy preferred standpoint as the principle controller can recognize the current position of the engine and track the nearness of any blunders. Right now in the market, certain models of DC servo engine accompany the shut circle input as voltage (potentiometer) or heartbeats (encoder). Actually, these criticisms work comparatively to the "inside" input where it is relative to the precise position of the engine shaft. This paper focuses on the use of DC servo motor with voltage position feedback as shown in Figure below:
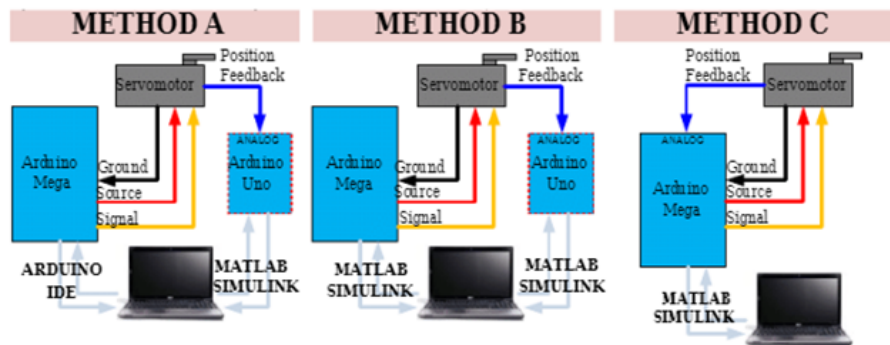

Fig. 6. The summary of the hardware setup

2) Software and hardware setup: For the purpose of this study, the hardware was set up to straightforwardly control the position while following the genuine position of the servo engine. The equipment setup comprises of Arduino Mega as the fundamental controller and the power wellspring of the servo engine. On account of Method A and Method B, another Arduino board (UNO) was acquainted with go about as the Data Acquisition Hardware (DAQ) to monitor the simple voltage input from the servo engine. The simple criticism information was then perused continuously by utilizing Arduino IO package. The genuine precise position of the servo engine can be watched. Not at all like Method A and Method B, the equipment setup for Method C just requires an Arduino Mega to control and obtain feedback information from the servo motor. The summary of the hardware setup is shown in Figure 8 below:
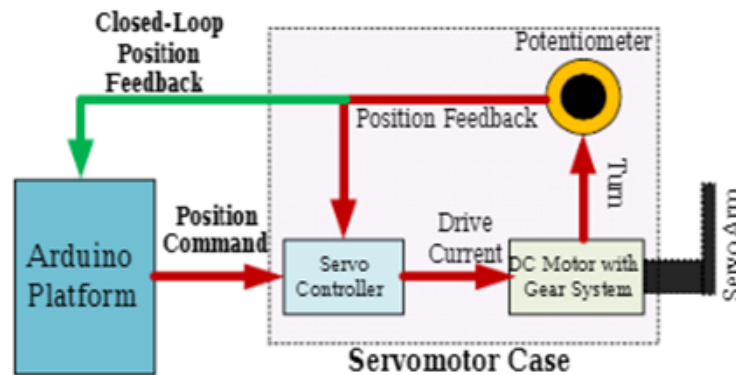

Fig. 7. The block diagram of DC servo motor with closed-loop voltage feedback

F. Wireless Data Logger Using ZigBee

This paper delineates natural parameters checking at a remote unit dependent on Arduino equipped for transmitting the parameters to the primary unit which later procedures for further ecological forecasts. This likewise clarifies the pragmatic usage of the remote correspondence convention utilizing ZigBee, information logging, processing utilizing VB.net [17].

1) System architecture: ZigBee wireless sensor nodes fundamentally comprises the sensor unit, checking and controlling unit comprises of microcontroller (MCU), ZigBee modules, and different segments. Microcontroller is in charge of gathering ecological data, (for example, temperature and stickiness) and does simple to advanced information change whenever required. Microcontroller is likewise in charge of controlling and dealing with the whole hubs. ZigBee modules are in charge of the correspondence between various hubs.

Sensor unit is the essential unit of remote sensor organize. Sensor unit is utilized for detecting the earth temperature and stickiness esteems, gathering data and changing over to advanced flags and checking unit is contained information procurement module and information preparing module. Information obtaining module gets the information from sensor unit and information handling module settles on the choices as per the earth conditions.

2) System design: The system classification are dissected into the follow
• Wireless Sensor Nodes
• Base Station GATEWAY
Hardware of one sensor node is described as shown in Figure below. In order to monitor the values of natural parameters observed at remote area of the room, a PC based Base station is produced and displayed in Figure 8. As portrayed in Figure 9. The base station comprise of the ZigBee module as the remote recipient. The parameter esteems which are as of now aligned at the sensor hub are perused sequentially into the PC and showed on the screen on particular planned windows.
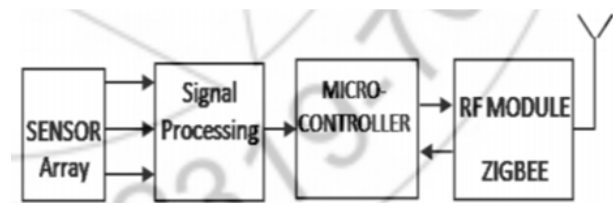

Fig. 8. Block diagram of the wireless sensor node

G. WSN System Design using Raspberry Pi and Arduino for Environmental Monitoring Applications

With over decade of serious innovative work, WSN innovation has been developing as a suitable
answer for some imaginative applications. In this paper, we

portray a remote sensor arrange framework that we have created utilizing open-source equipment stages, Arduino and Raspberry Pi. The framework is minimal effort and profoundly adaptable both as far as the kind of sensors and the number of sensor hubs, which makes it appropriate for a wide assortment of utilization identified with natural observing. In general framework design and test organization and estimation results are likewise introduced to show the convenience of the framework [18].
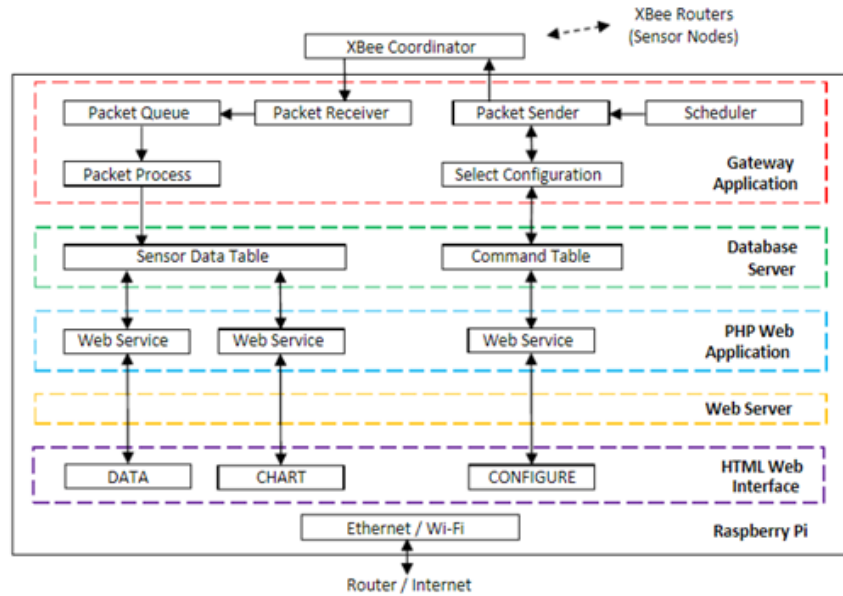

Fig. 9. Functional block diagram of base station

1) Design of base station: For the base station, we utilized a low power charge card estimated single-board PC Raspberry Pi Model B. The CPU on the load up is an ARM processor with 700 MHz clock speed. CPU execution can be contrasted with a Pen-tium II 300 MHz processor and the GPU execution is like the first Xbox. It has an assortment of interfacing peripherals, including USB port, HDMI port, 512MB RAM, SD Card stockpiling and strikingly 8 GPIO port for development. Screen, console, and mouse can be associated with Raspberry Pi through HDMI and USB connectors and it tends to be utilized like a personal computer. It underpins various working frameworks including a Debian-based Linux distro, Raspbian, or, in other words our structure. Raspberry Pi can be associated with a neighborhood through Ethernet link or USB Wi-Fi connector, and afterward it very well may be gotten to through SSH remote login. Utilitarian building squares of the base station, including passage application, database, and web application, are appeared in Figure 9. Raspberry Pi is associated with the XBee facilitator module through a USB link and a USB-to-UART sequential converter circuit. The door application is the middle layer between sensor system and database. It conveys configuration and information gathering directions to sensor hubs and additions the information got from sensor hubs into the MySQL database. The door application is modified in Python that comes worked in with Raspbian. A portion of the required Python bundles incorporate Py-Serial 2.7, MySQL-python 1.2.5, Advanced Python Schedule (APScheduler 2.1.2), and XBee 2.1.0. The web application is worked with Apache HTTP web server, and the server-side web administrations are HTML web interface through Ethernet or Wi-Fi association inside the neighborhood or from anyplace on the Internet when configured suitably on the switch. The server-side web administrations are modified in PhP. Clients can get to the HTML web interface through Ethernet or Wi-Fi connection inside the local area or from anyplace on the Internet when arranged fittingly on the switch.
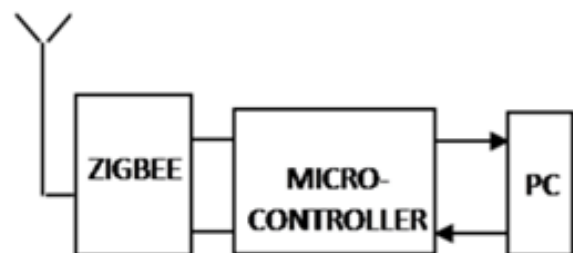

Fig. 10. Block diagram of the base station-GATEWAY

H. WSN Based Atmega16 Microcontroller as Temperature and Current Monitoring System on Distribution Network Transformator

Distribution transformers is one of the fundamental components in electrical dissemination framework to client. This transformers are utilized to change the contribution of the transformers from 20 KV to 220 Volt. Conveyance transformers regularly have disturbance, and in the event that it isn't settled soon, it will harm transformers and fire it. One of the parameter that demonstrate disturbance in transformers is improvement of current and temperature of transformers altogether.
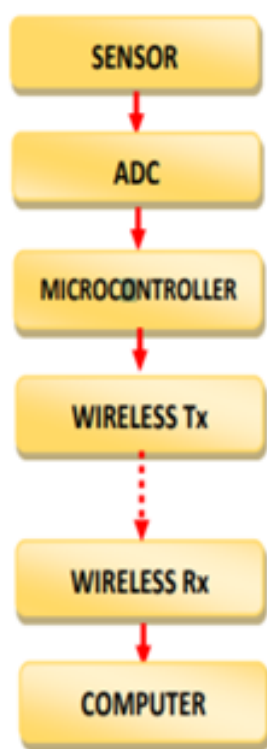

Fig. 11. Block diagram simulator WSN

A checking framework is expected to abstain from harming the transformers which utilizes current and temperature as a parameter. A checking framework can be worked by remote sensor organize as the fundamental framework which each hub can deal with in excess of one sensors that can be controlled from far away. This exploration points: (1) to get reenactment arrangement of remote sensor organize as an observing framework dependent on Atmega 16 microcontrollers, (2) to examine remote sensor organize as a checking arrangement of conveyance transformers. Strategy that is utilized in this examination is Research and Development. Which begins from making the test system and after that

make reproduction with the equipment that has been made, and break down information from re-enactment. Consequence of this examination demonstrated that: (1) the simulator that has been made is work fine and drawing nearer with the framework in a genuine world, (2) in view of relapse investigation, the regression line is huge to foresee Y esteem (temperature) in view of X esteem (current), which has connection esteems is 96.2%, with inclination and relative blunder for current qualities is - 0.038 and 2.52%, predisposition and relative mistake for temperature esteems is 1.008 and 1,21% [19].

1) Methods: This study included into this type of research and development which stage in the research is a simulator tool manufacture, testing, data analysis and the results of testing tools. Making the WSN simulator refers to the working principle as follows: Simulator consists of several circuit blocks that are separated from each other, consisting of: (1) power supply module, (2) minimum module system, (3) the sensor module, (4) ADC module, (5) wireless module, (6) USB ASP module, (7) RS232 module, (8) LCD modules.

III. METHODOLOGY

The system design as shown in Figure 12 below is consist of the air and ground section of the network. In this section, is the outline of electronic components needed for the development of the avionics/communication system.

A. Air Section: Its Functions

1) Inertial measurement unit: (Compass, gyroscope and accelerometer) is an electronic device that measures and reports a body's specific force, the angular rate, velocity and magnetic field surrounding the body that is used to maneuver the UAV. The develop system uses the IMU coupled to GPS, giving the navigation information for the heading, pitch, roll and distance.

2) GPS: is a utility that supports the navigation performance, where the reliability and integrity checks of the GPS data is essential which makes the system reliable.

3) Camera: is an electronic device that captures and records images.

4) Servo Motor controller: is a circuit that is used to control the position of a servo motor for the upper and the lower wings of the UAV. It is consists of a controller, servo motor, and the power supply unit.

5) Parachute controller: was primarily designed for parachute deployment of UAV. It is consist of a single servo motor that can open a latch on a parachute door. The custom firmware acts as a timer and a servo motor driver which then monitors a trigger switch to open the parachute door.

6) *The transceiver:* is device that combines the transmitter/ receiver in a single package that is used for wireless communication device for air section and ground section.
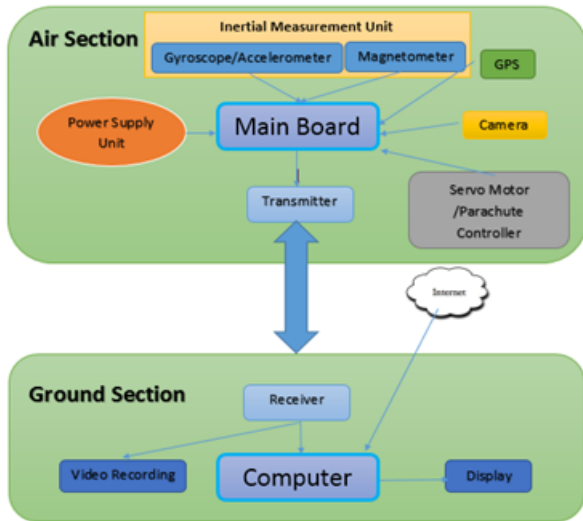

Fig. 12. The ESN

7) *Arduino Uno:* is a micro-controller board that is used to control servo motor and synchronize the movement of the wings of the UAV and the deployment of the parachute.

8) *Microcontroller:* is a main board used for collection and transmission of data in the ground section.

B. Ground Section: Its Functions

1) *FPV transmitter and receiver aomway DVR with dual 5.8GB:* is a device that is used for video recording from FPV camera models directly on a micro SD card. The Monitoring Section is a software component that uses Matlab to monitor resources and performance of WSN.

IV. RESULTS AND DISCUSSION

This section contains the results and discussions, flow chart of the air and ground section, tables and data gathered through a series of functionality tests of a system.

The result of this study is to test the developed system for localization, target identification, guidance and control using fins and release mechanism for steering at different angle of inclination as well as to determine the efficacy of the system through actual field test.

As shown on Figure 13 Projectile Tracker flow chart below, it shows the program implementation of Projectile Tracker Display.

As shown on the Figure 13 flow chart, it shows the process for the implementation of program in the air section and ground section. The circuit layout as shown on Figure 15 Circuitry of Air Section below is the design that includes the integration of the overall design.

The circuit as shown on Figure 16 Circuitry of Ground Section below is the layout of the ground section, which includes the following components sush as the Receiver, and Universal Asynchronous Receiver-Transmitter (UART) to USB converter, Laptop, and the Aomway for video recording.

Since this study uses a Matlab application for projectile tracking monitoring, Figure 17 Projectile Tracker Display below shows the simulated projectile tracking display using it. To be able to connect the Projectile Tracker Display and be activated, internet connection is strictly necessary. If the Connect button remains green in color, it means it is not yet connected. Figure 18 Projectile Tracker Display shows the actual data logging where in the Connect button turned into red which indicated that it is connected. As shown, the real-time communication system in surveillance, tracking, and monitoring applications are fully equipped. As shown on Table 1 below, it shows the actual data gathered during the testing.
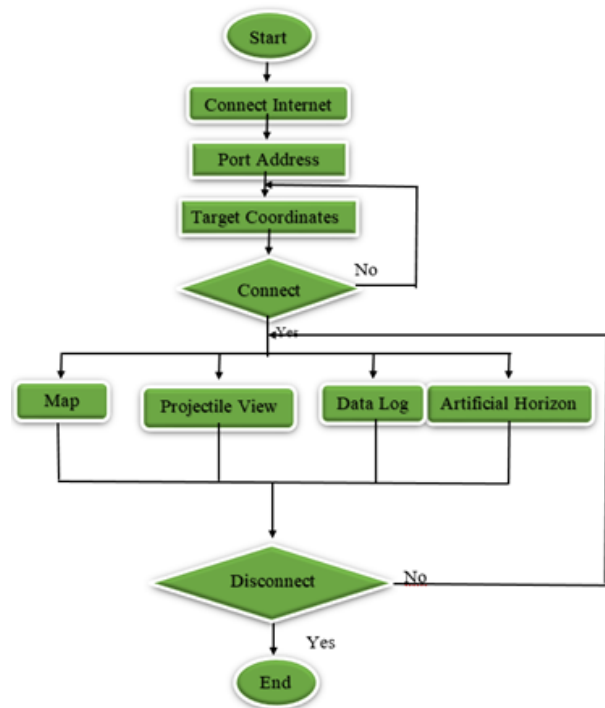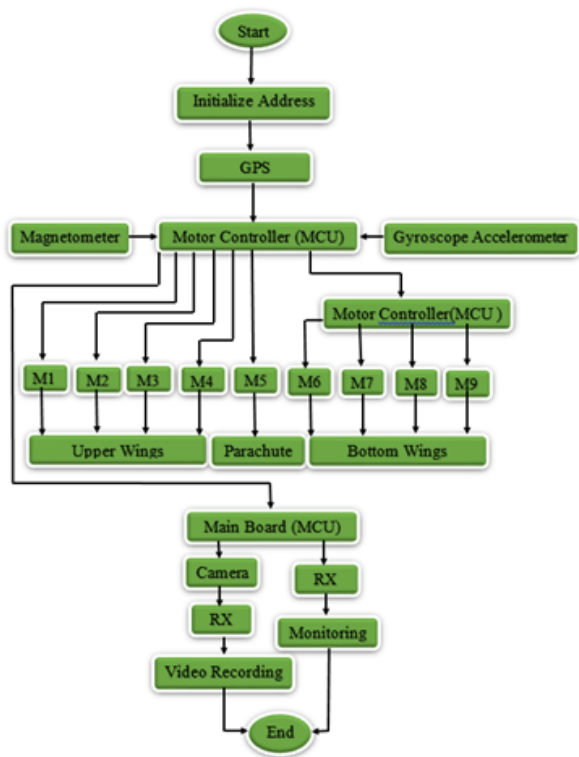

Fig. 13. Projectile tracking flowchart
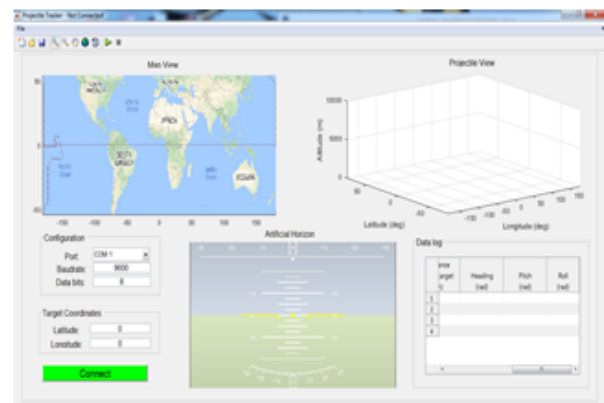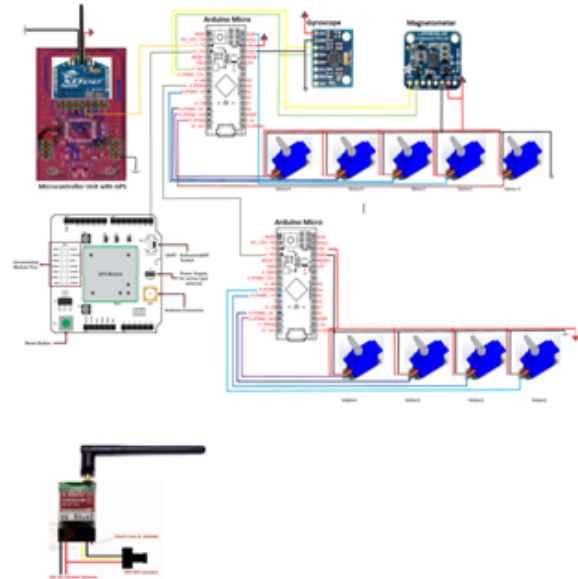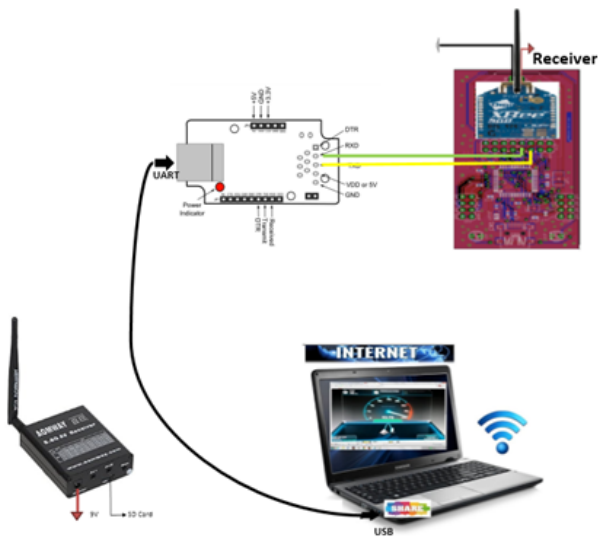
Fig. 14. WSN flow chart

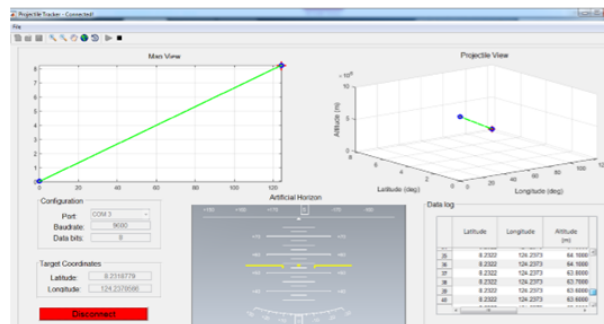Fig. 16. Projectile tracker display(Off)

Fig. 15. Circuitry of ground section

Fig. 17. Projectile tracker display(On)

TABLE 1
DATA LOGGER

Latitude	Longitude	Altitude	Distance from Target	Heading	Pitch	Roll
8.232150	124.237190	38.799999	51.352114	4.570000	1.210000	-0.080000
8.232140	124.237167	37.000000	48.616440	4.620000	1.010000	-0.050000
8.232130	124.237152	35.600002	46.512249	5.330000	0.940000	0.0400000
8.232140	124.237160	48.600002	47.427520	5.520000	1.000000	-0.080000
8.232130	124.237130	48.600002	56.181277	4.890000	1.210000	-0.029000
8.232170	124.237030	51.399998	60.879665	5.080000	1.040000	-0.300000
8.232170	124.237099	52.000004	61.490155	4.660000	1.160000	0.0500000
8.232200	124.237251	60.299999	13769981.489	5.080000	-0.340000	0.070000
8.232190	124.237267	59.700001	13769983.267	4.110000	-0.430000	0.110000
8.232170	124.237282	60.200001	13769985.148	5.120000	-0.210000	0.060000
8.232170	124.237282	60.600002	13769985.148	5.450000	-0.410000	0.210000

A. Pressure Vessel

Figure 18 below shows the setup of controls for the servo motor controller of the semi-ballistic UAV.
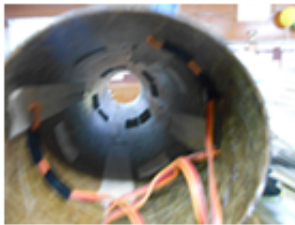

Fig. 18. Actual setup of control

Figure 19 shows the semi-ballistic UAV which is powered by a combination of a water and the air pressure where the pressure vessel uses a plastic soft drink bottle. The pressure vessel is reinforced with carbon fibre mat composite materials. The reinforced materials is made of carbon fibre mat and Polyklear ACM Blue Glass Fiber E-CSM Surfacing with the reinforcement of the Polyklear Epoxy Resin A and B.

Fig. 19. Semi-ballistic UAV

V.   CONCLUSION

The conceptualization and implementation of the WSN applications were realized. The multi-sensor fusion and integration for communication between these two sections were successfully accomplished in the overall design and performance enhancement of the semi-ballistic unmanned aerial vehicle being developed. Based on the data gathered, the researcher concludes that the developed system is reliable, functional and efficient in locating the target and monitoring the precise search and rescue operation. The researcher believes that the 100% achieved success rate of the system based on the limitations of the study. The developed WSN system, thereby achieves the purpose of the study. However, more studies must pursue by using the motor rocket for a pressure vessel to achieved more efficient system.

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