KONG WOBBLER BASE STATION FOR DISASTER MANAGEMENT

[1]Sandeep Sagar K S, [2]Dr. Narendra Kumar G
[1]Research Scholar, [2]Professor
[1]Department of Electronics and Communication Engineering,
[1]University Visvesvaraya College of Engineering, Bangalore, India

Abstract: Seamless connection is the priority in cellular networks and in the landmass, during flood affected area, the existing mobile network is snapped due to disaster and non-functioning of base station leading to call block/call drop. A drone is deployed to survey the affected geographical area and analyse aerially, estimating prospective base stations required to restore communication with the globe. The required number of Kong Wobbler Base Stations are air dropped at specified strategic points estimated by the disaster management. Light weight prototype Kong Wobbler low power base stations is designed to the specifications similar to existing base stations which have self-reliant solar power. Affected customers re-establish connections to locate them in the affected disaster area.

IndexTerms – Disaster Management, GSM, Kong Wobble.

I. INTRODUCTION

Unmanned Aerial Vehicle(UAV) contempt to aircraft with no pilot, which is also known as Drone [1], plays a major role in public safety scenario and is widely used in monitoring affected environment.

Surges are among Earth's most normal and most ruinous characteristic perils as water floods or immerses arrive which can occur in a huge number of ways. Extreme rain, a burst dam or levee, quick ice dissolving in the mountains or even a tragically put beaver dam can overpower a stream and send it spreading over the adjoining land. Flooding occurs across coastal area due large storm or tsunami causing the sea to surge inland, dam and levees breaking which further can be activated by rainstorms, violent winds, production of low weight locales.

Floods are the most calamitous and disastrous occasions of all the catastrophic events. World Meteorological Organization(WMO) has expressed that out of the considerable number of calamities on the planet, the most serious debacles influences a large number of individuals over the world prompting extreme death toll and goliath harm to property, foundation and horticulture. In India, around 18% of the land is helpless against the floods conditions with uncommon precipitation brings [2] about surges conveying typical life to a halt.

Disaster due to floods, the communication network which is critical for common man to coordinate with other person since cellular network is damaged. Communicate immediately after a disaster situation [3] is a critical part of response & recovery, in that it connects affected people, families and networks with specialists respond to the call, Dependable and available communication and information systems are very critical to restore the community's normal situation. Since, there is no network connectivity the basic need is re-establishing communication network. This research explains one of the most effective, cost efficient practical solution for that kind of situations. The communication can be restored air dropping the Kong Wobbler Base Stations (KWBS), [4] towers which do not topple for any situation availing communication through the Base Station(BS) for public. The KWBS also uses GSM, Arudino Uno open-source microcontroller board.

Four important routing protocols such as Ad hoc on Demand Distance Vector (AODV) protocol, Destination Sequence Distance Vector (DSDV) protocol, Dynamic Source Routing (DSR) and Enhanced Ad hoc on Demand Distance Vector (EAODV) are analysed and evaluated for various performance parameters of an Ad hoc network.

Brief outline of this research;

In Segment II proposes Design of Kong Wobbler, design of system architecture is explained in III, IV describes Implementation, showing the simulation results details in V and comparison with sliding mode controller is presented followed by conclusion in VI.

II. DESIGN OF KONG WOBBLER

Kong Wobbler is manufactured by Polypropylene, which is made up of high strength polymer because it is having high strength, impact absorption, sound deadening and non-toxicity. The Kong Wobbler adopts 'Archimedes principle' consists of base station mounted on top, which is made to float vertically around on the surface of the sea/water/slush for the area of investigation. The weight of the base station is less compared to Kong Wobblers base structure, maintaining a ratio of 1:4 to prevent the whole structure from toppling. The Base station tower is hand-launched on the Kong Wobbler and air dropped in the area of disaster. The Kong Wobbler structure tends to accelerate upwards because of the greater pressure at the bottom of the ocean compared to the top. The Kong Wobbler structure with base station tends to restore itself to an equilibrium position and creating a greater buoyancy force, Fig 1.

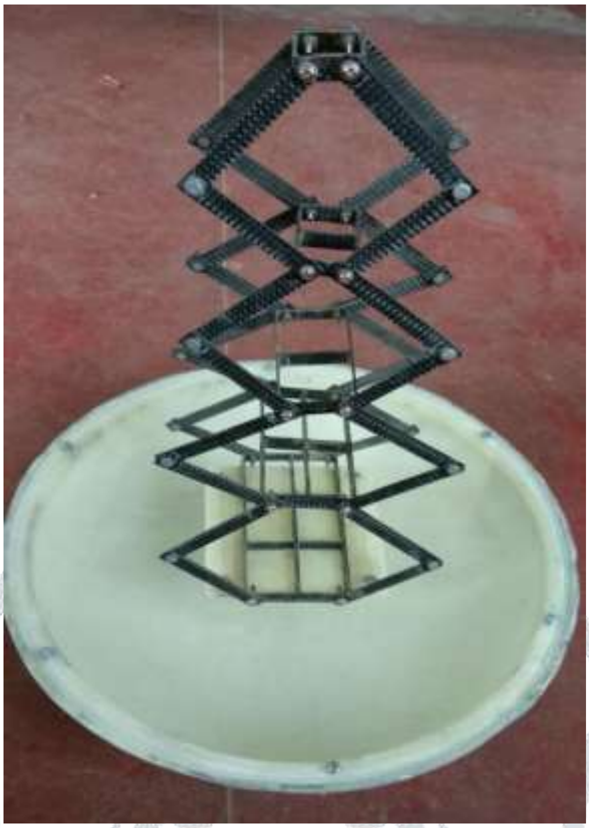

Fig. 1. Kong Wobbler Tower

2.1 Component Description

The Kong-shaped Wobbler is an action-packed treat toy that sits upright until pushed and periodically dispenses as wobbles, spin and rolls.

2.1.1 Polypropylene

Polypropylene is a semi-crystalline polymer that is used notably due to its specific aggregate of properties, fee and simplicity of fabrication. all grades consist of polymer, a neutralizer and antioxidants. different components like clarifiers, nucleates, slip components, UV stabilizers, silica, talc and calcium carbonate are added to impart precise capability. the polymer is be a pure homo-polymer made with the help of polymerizing propylene, a random copolymer made from propylene and another monomer or an impact copolymer made by means of dispersing rubber in polypropylene matrix.

2.1.2 Carbon Fibre Tower

Tower is a cellular site with antennae and electronics equipment. Towers are made up of steel. Using Carbon fibre in the tower lowers material weight up to 90%. Major benefits from a carbon fibre structure are less environmental impact, longer lasting and faster installation/construction cost.

2.1.3 Environmental Impact

The manufacturing of carbon fibre towers uses recyclable material. Steel fabrication is a high energy process, whereas the production process of carbon fibre is relatively energy efficient.

2.1.4 Longer Lasting

Carbon fibre does not rust and corrode like steel structure, lowers the tower maintenance cost and is long lasting tower can last for 50 years in comparison with steel towers (20 years), especially nearby marine environment.

2.1.5 Faster Installation

As carbon is around 90% lighter than steel it requires lighter installation equipment, less foundation to support the tower which leads to lower installation cost and faster time for construction. It is estimated that carbon fibre tower structure can be construct 20%-30% faster when compared to traditional steel structure tower.

2.1.6 Lithium Ion Battery

Lithium is lightest of metals and it is able to flow on water by extraordinary electrochemical properties and relatively reactive material, capability to obtain very excessive electricity and power densities in high-density battery and standby power called re-chargeable batteries. In the course of the rate and discharge tactics, lithium ions are inserted or extracted from interstitial space between atomic layers within the active material of the battery

2.2 KONG WOBBLER STRUCTURE DESIGN

Kong Wobbler toys are made in such a way that they do not topple even in the sea. The descriptions and dimensions of Kong wobbler,

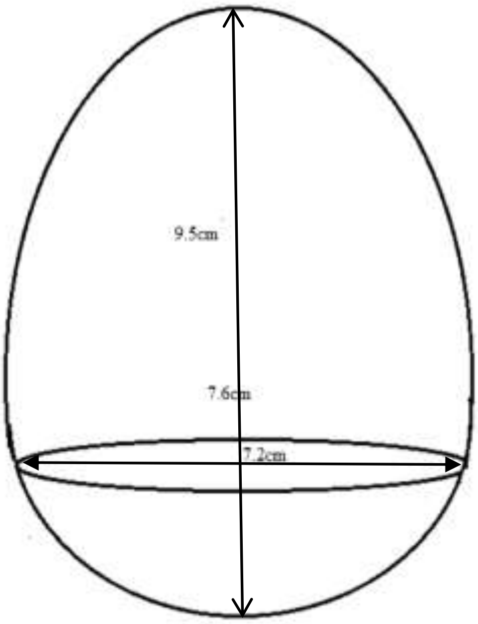

Fig. 2. Dimension of Kong Wobbler Toy

Total length = 9.5 cm
Length of lower half = 3cm
Length of upper half =7cm
Considering exact semicircle constitute the lower part, circumference obtained is 23.8cm. Hence, radius is calculated by using the formula
Circumference $=2\pi r$=23.8, r=3.8. Hence, diameter =2r= 7.6cm

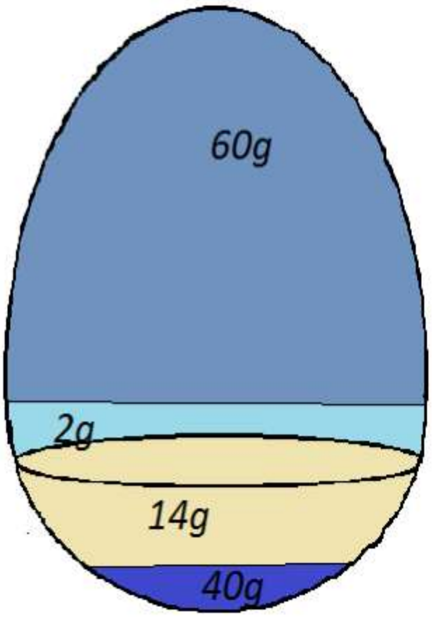

Fig. 3. Weight of different part of Kong Wobbler Toy

Weight of the upper part, 60g
Weight of the lower part, 14 kg
Weight of metal added at the base, 40kg
Weight of the battery which included in lower semicircle is, 14kg
Weight of the part included in the upper part and below the semicircle can be obtained

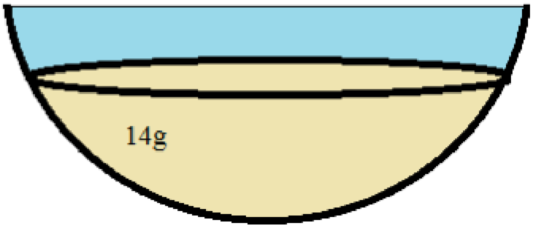

Fig. 4. Weight of lower part of the Toy

As, Volume of the circle with diameter 7.6cm $=\pi r^3= \pi(3.8^*10^{-2})^3$
$=1.07238*10^{-4}$m

Volume of the semicircle = $80619*10^{-5}$m
Volume of the circle with diameter 7.2cm$=\pi r^2= \pi(3.6*10^{-2})^3$m
$=1.4657*10^{-4}$m

Volume of the semicircle = $7.3287*10^{-5}$m
Weight of the semicircle of radius 3.6cm is 14g
Calculation of the weight of the semicircle of the radius 3.8cm is
$7.3287*10^{-5}$ is 14g
$8.619*10^{-5}$ is 16g
Weight is = $(8.619*10^{-5}*14)/ (7.3287*10^{-5})$ =16.46g
Hence the weight of the remaining volume is=16.46-14=2.46g
It is approximated as 2g.

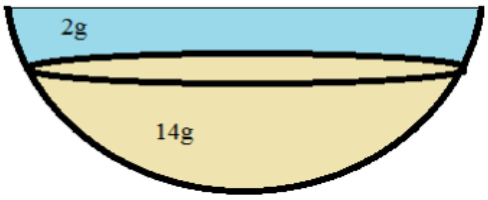

Fig. 5. Weight of lower semi sphere

Lower hemisphere consists of battery, metals. Sum is the total weight.

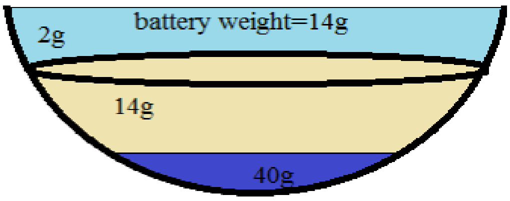

Fig. 6. Weight including battery

Total weight =weight of surface + weight of batteries + weight of metal
=14g+2.5g+14g+40g =60g
Weight of the upper part is 60g
The proportional weight
Weight of the upper part: weight of the lower part =60:70.5=1:1.175
Proportion of the weight of base to other part weight is 4: 3

Table 1 Base Station Tower Specification

Base Station Tower	**Steel**	**Carbon fibre**
Height of the tower	12m	12m
Weight of tower structure	2,507.71kg	250kg
Weight of antenna	64kg	7kg
Weight of foundation	692.10kg	300kg
Power requirement	7.5kw	7.5kw
Base size of the tower	1.5m*1.5m	1.5m*1.5m

Base Station Tower

Base size of the tower is 1.5 m

Radius of the sphere to moult the tower, calculated using the Pythagoras theorem.

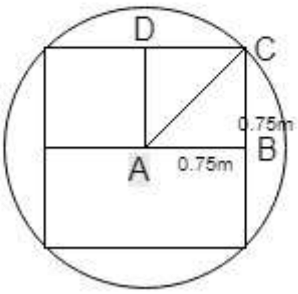

Fig. 7. Base of the Tower

ABC form the right-angle triangle

Pythagoras theorem,

$AC^2=AB^2+BC^2$

$AC^2=0.75^2+0.75^2$

$AC^2=1.125$

$AC=\sqrt{1.125}$

$=1.060$

Radius is 1.060m

Diameter =2r=2*1.06=2.12

1.060m is the radius of the segment of the sphere

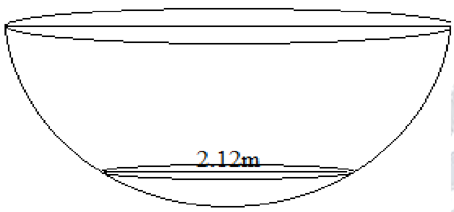

Fig. 8. Radius of the base

Fig. 9. Base station in Kong Wobbler

At the bottom of the semi sphere base foundation of the tower is included.

To find the radius of actual semi sphere, using the ratio of the radius of the Kong Wobbler toy.

Radius of the segment is 2.4cm

Radius of the semi sphere is 3.8cm

Ratio of the radius is 2.4:3.8

Radius of the semi sphere is 1.06m

Proportion is 2.4:3.8::1000.06:1583.43

Radius of the semi sphere = (3.8*1000.06)/2.4 =1.68m

Radius of the actual hemisphere is 1.68m

The diameter is 3.38m

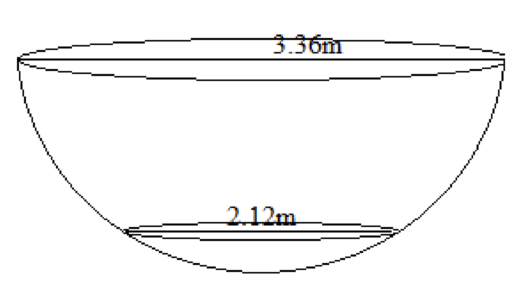

Fig. 10. Radius of whole structure

The weight of material required for the designed semi sphere

Density=weight/volume

Weight=density*volume

Density of on board ultra-stiff polypropylene =570kg/m^3

Diameter of the inner semi sphere is 3.36m

Radius is 1.68m

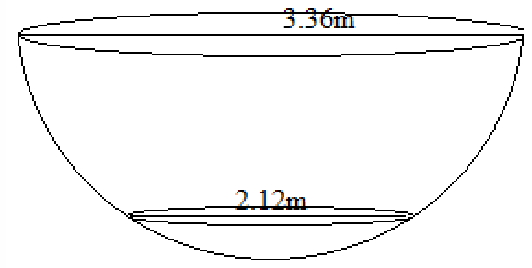

Fig. 11. Dimension of the semi sphere

Volume of the sphere $=4/3\,\pi r^3$

$=4/3\,\pi(1.68)^3$

=19.86m

Volume of the semi sphere = (volume of the sphere)/2

=19.86/2

=9.93m^3

Thickness of the sphere which is moult the tower is 5cm

Therefore, diameter of outer semi sphere is 3.46m

Radius of the outer semi sphere is 1.73m

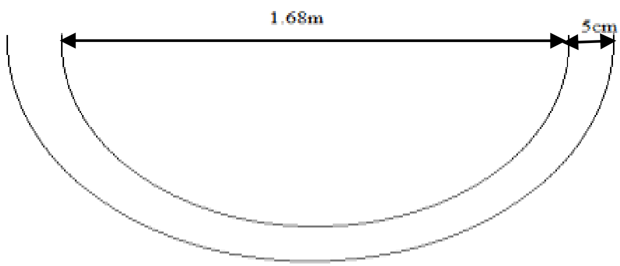

Fig. 12. Thickness of the whole structure

Volume of the sphere $=4/3\,\pi r^3$

$=4/3\,\pi(1.73)^3$

=21.688m^3

Volume of the semi sphere = (volume of the sphere)/2

=21.688/2

=10.84m^3

Required volume=outer semi sphere volume-inner semi sphere

=0.91m^3

Weight of the material required=volume*density

=518.7kg

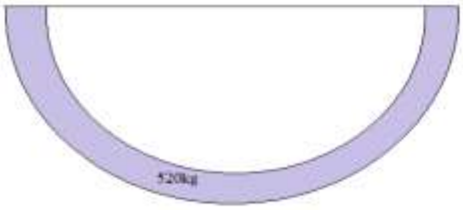

Fig. 13. Weight of the structure

Weight of the whole structure

Weight of the tower using carbon fibre = 250kg
Weight of the antenna =7kg
Weight of the foundation = 300kg
Weight of the semi sphere = 520kg
In the Kong Wobbler ratio of the weight of base to weight of material =4:3
So, in the designed structure weight of segment can be calculated
Volume of the segment=$\pi/6*h(2a^2+2h^{2)}$
a=radius of the segment=1.06
h= height of the segment=1.06
volume of the inner segment =$\pi/6*1.06(2*1.06^2+2*1.06^{2)}$
=2.494
volume of the outer segment =$\pi/6*1.11(2*1.11^2+2*1.11^{2)}$
=2.864
Required volume=outer segment volume-inner segment volume
=2.864-2.464
=$0.37m^3$
Weight of that volume =density*volume
=0.37*570
=210kg
Remaining weight is 520-210=310

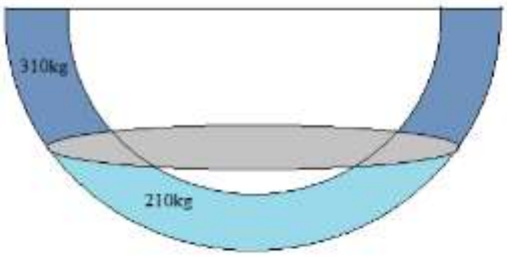

Fig. 14. Weight of the lower and upper part of structure

Total weight of the base of the structure =weight of the foundation + weight of the material =300+210=510kg
Weight above the foundation =weight of the tower + weight of the material=257+310=567kg
Weight of the solar panel =750kg
Weight of the battery=450kg

Total weight of the whole structure

Total weight=material weight + tower weight + foundation weight + solar weight + battery weight=520+256+300+750+450=2277kg

III. SYSTEM ARCHITECTURE

An area gets affected by the flood, the existing base stations will be destroyed, resulting in no communication between the public in the surrounding area. As soon as the information reaches the mainland, a drone is sent to survey the whole affected area, and the status is carried to the mainland station. As per the requirement, the number of base station required and the location to drop them is finalised. The helicopters carrying the Kong Wobbler base station are sent to the flood area. After dropping Kong Wobbler base stations in disaster areas, helicopters are sent back to mainland station. The public safety scenario, a Base Station(BS) with fixed energy supply desires to transmit its information to a destination located in the flood affected area, Fig 15. Based on the communication established between the people in disaster areas.

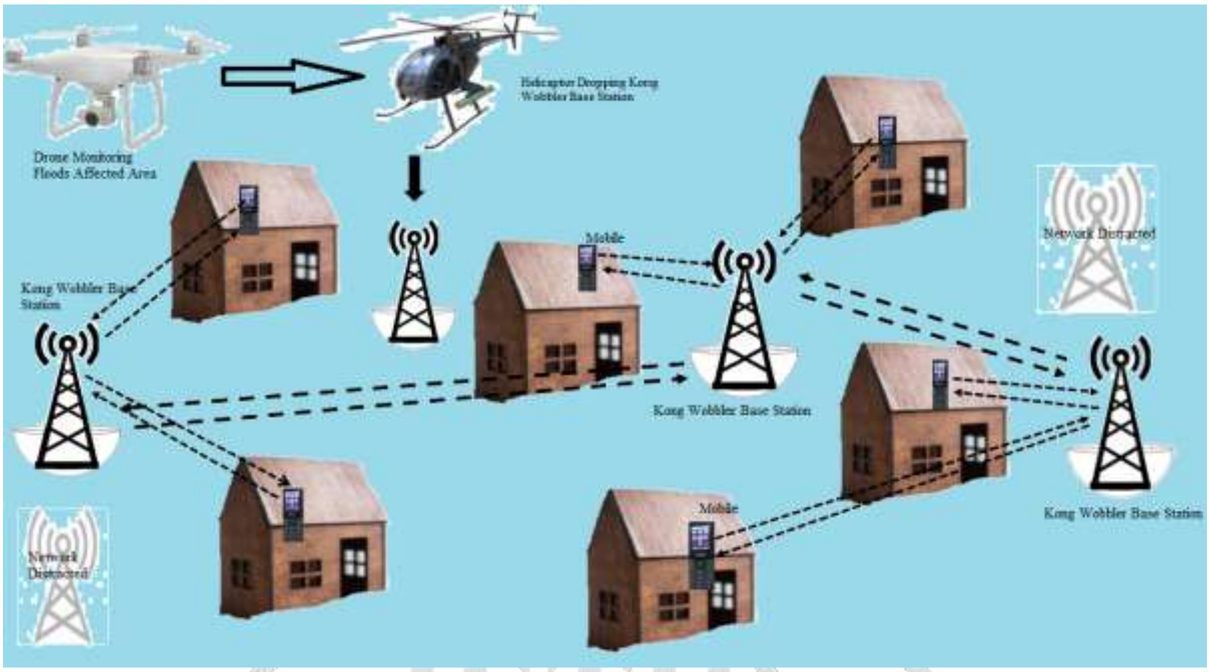

Fig. 15. Disaster caused by Floods

The Kong Wobbler base stations, firstly forms a link by communicating among themselves. Once this link has been built, the communication between the mobile phones present in the surrounding area is established, by these Kong Wobbler base stations. The simulation of the above scenario is done using NS2 software, and EAODV protocol. As this is the most efficient protocol compared to DSDV, DSR and AODV protocols.

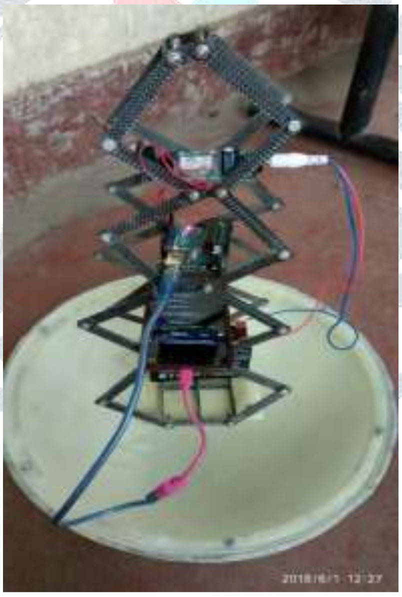

Fig. 16. Establishment of Communication

The GSM module, Arduino, Rechargeable battery and a mobile phone is used to construct the base station model. The GSM module is used to send and receive messages from the mobile phones to the base station. Arduino board is used to dump the program to send and receive messages, Fig 16. The rechargeable battery is used to ensure the continuous power supply, which can even be recharged by setting up solar panels. The total setup can work to send and receive messages from the surrounding mobile phones.

3.1. IMPLEMENTATION

In flood areas during a disaster, the existing mobile network is snapped due to the disaster and non function of base station leading to call block/call drop. Hence, a base station is required to build. So the Kong Wobbler base station is built to communicate with the public during disaster management. To build KWBS firstly, Drone surveys the flood affected area.

Within a very short period of time, simultaneously, it sends information to the base camp. Once the surveying is done, which implies helicopters, there after dropping KWBS, returns back to base camp. These BS, first forms User Datagram Protocol (UDP) link with each other BS. Once this is done, the public mobile start sending Route request (RREQ) to the base station in order to start communication. Once it gets Route Reply (RREP) from the KWBS the connection will be formed and the information exchange starts. The public starts communicating with each other easily among themselves and they start receiving requests from the surrounding mobile stations for the communication establishment. The flowchart, depicts performance of communication in disserted management in a particular area, Fig 17. The BS, facilitates the communication between all the mobile station. In case the RREQ fails again the Drone starts monitoring and process repeats as described.

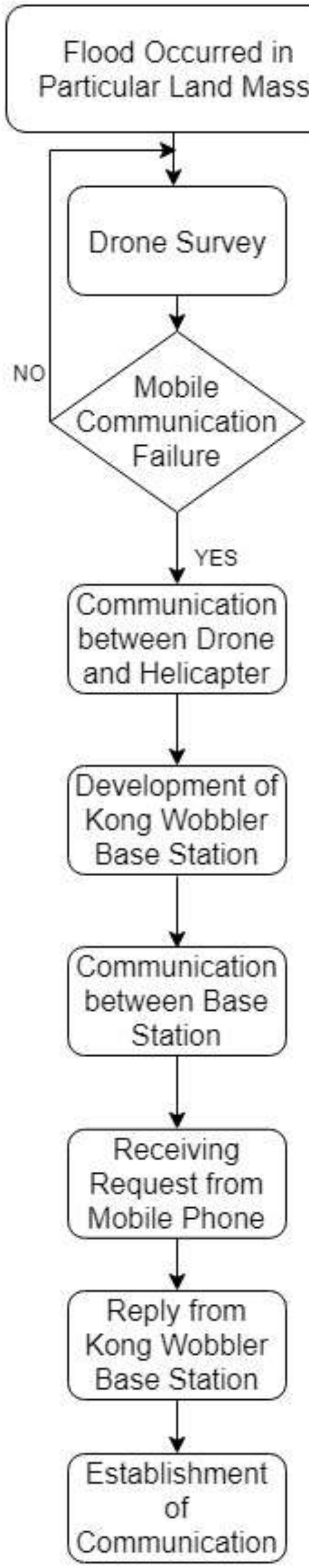

Fig. 17. Communication in Disaster Management

The hardware is implemented using the Kong Wobbler and a base station mounted on the top of it. This base station model contains a GSM module, through which the messages are sent, an Arduino board, on which the code for sending SMS is dumped, a rechargeable battery which provides the continuous power supply for the system. A mobile phone, which acts like a computer is also used in the hardware module. Whenever there is an emergency, the messages are sent to the nearby mobile stations from the base station and hence, the connection will be established.

IV. RESULTS AND DISCUSSION

The detailed simulation of AODV. DSDV, DSR, EAODV are explained, along with hardware working process.

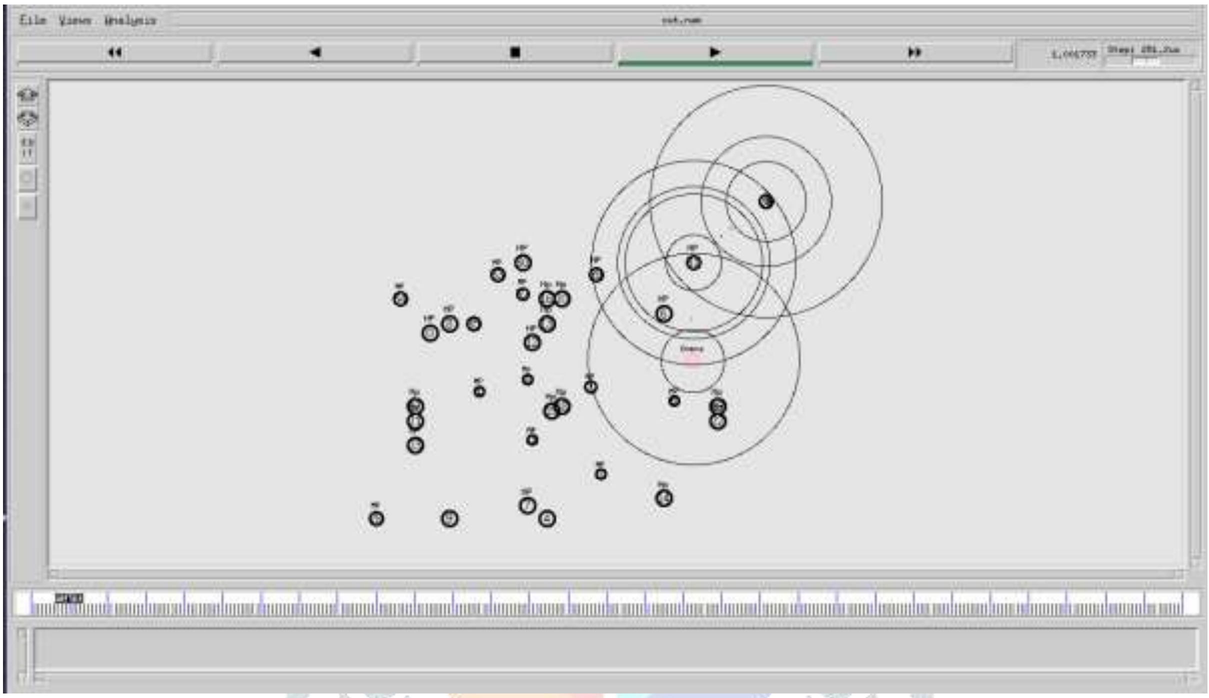

Fig. 18. Surveying by Drone in Flood affected area

The implementation of model of ad hoc network, initially the Ad hoc network model is tested, Fig 18. The Surveying of drone is done in the disaster area. Drone starts monitoring the flood affected area.

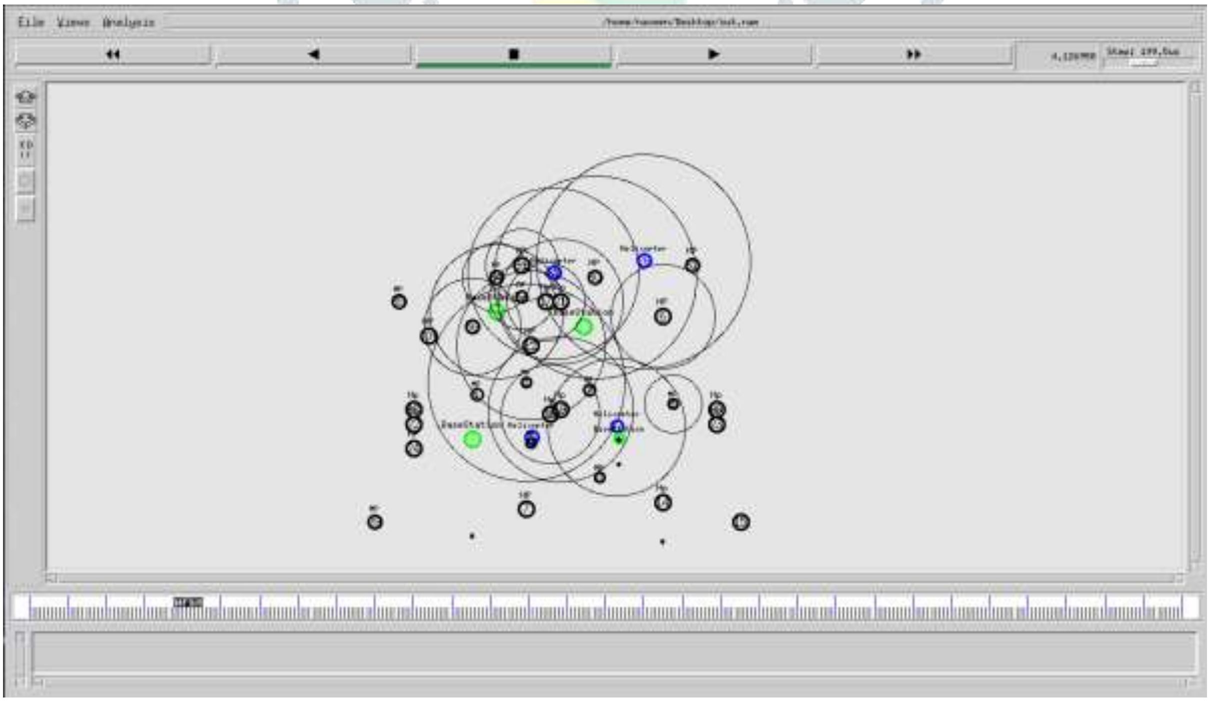

Fig. 19. Air dropping of BS in Flood affected area

After the completion of surveying by Drone, it starts communicating with Helicopter. The helicopter starts to move in flood disaster area drops KWBS in Disaster Management area, to establish network between each other BS. Helicopter in blue colour node, Fig 19 and KWBS in Green Colour node.

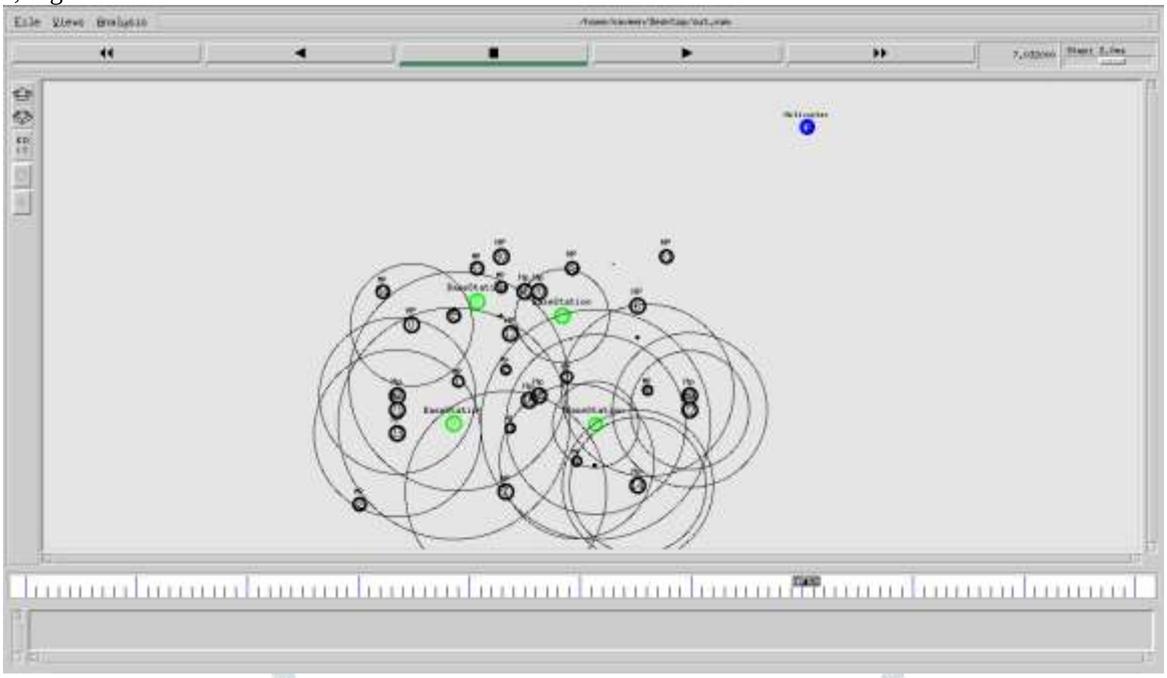

Fig. 20. Establishment of communication using AODV protocol

After dropping the KWBS in flood affected area, firstly communication is established between KWBS. Then, communication starts between public through KWBS. Public node in black colour. In AODV, Fig 20 packet loss increased comparing to EAODV.

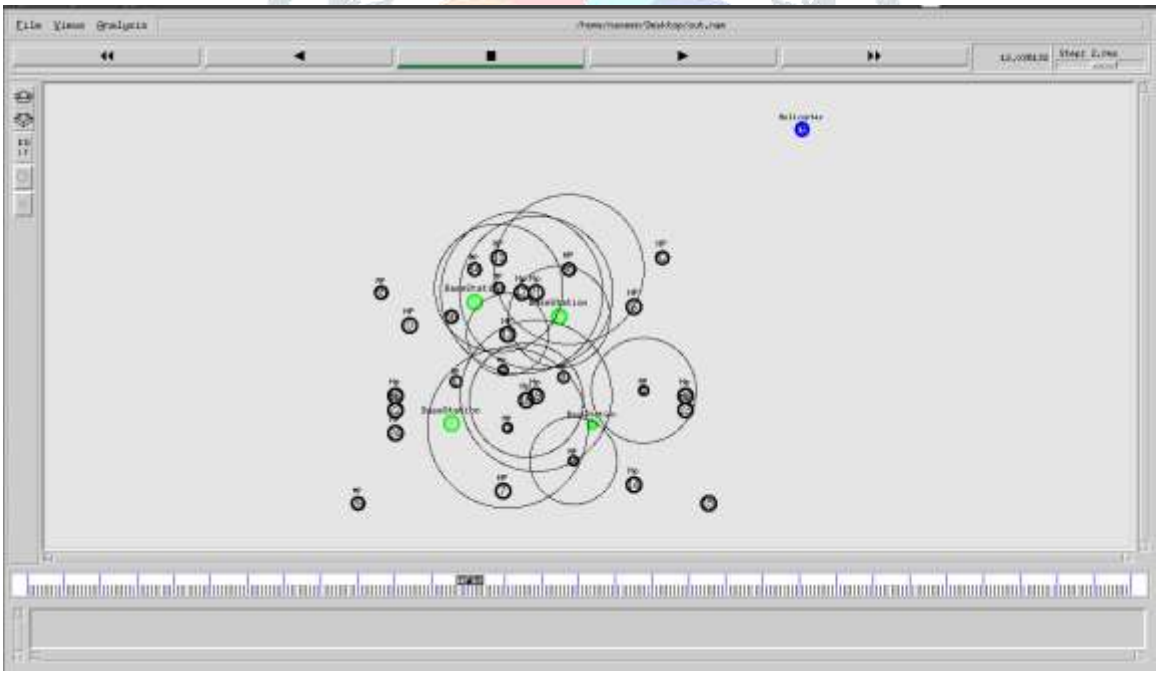

Fig. 21. Establishment of communication using DSDV protocol

KWBS develops communication in between mobile/public. The routing protocol DSDV results in a minimum number of packet loss not less than that of EAODV, Fig. 21.

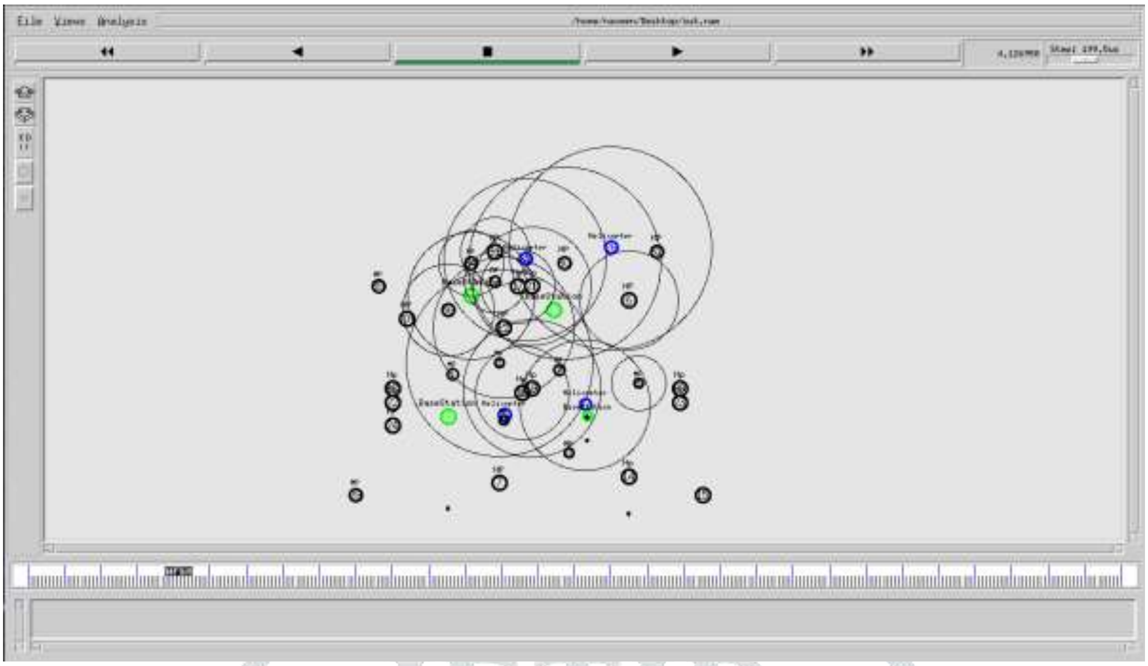

Fig. 22. Establishment of communication using DSR protocol

All the Mobile/public gets connected with KWBS. DSR gives higher ratio of packet delivery in mobile random networks, DSR protocols but not as that of EAODV, Fig 22.

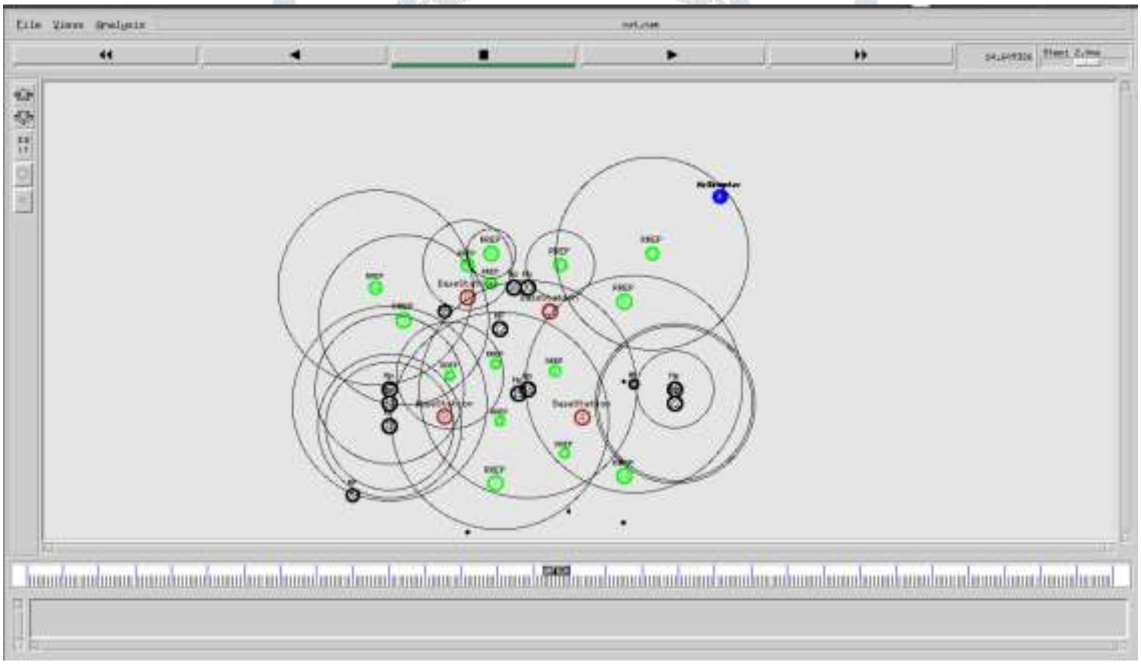

Fig. 23. Establishment of communication using EAODV protocol

Nodes getting activated with KWBS communicate with each other. The multi-hop access network in EAODV connectivity interfacing with other public/mobile BS to KWBS. In this scenario, the packet delivery ratio of EAODV is better than that of other protocols, Fig 23.

Fig. 24. KWBS Communication through GSM module

Fig. 25. Received message from GSM Module

The communication has been established between the GSM module and the mobile in the surrounding area the message has been sent/ received as well, Fig 25.

V. CONCLUSION

In the research work, public safety network and BS communications are investigated. An optimal communication route for network is designed for emergency or disaster management. This helps to maximize the bridge between functional area to non-functional area and to minimize the end-to-end disconnection. Drone is efficient in real time monitoring of disaster caused by floods. The proposed system has been effectively designed and implemented the new Base Station in the disaster affected area. KWBS performance as a BS in the disaster area takes control, builds communication between the public/Mobile and others as the existing BS is totally affected by disaster caused during floods.

REFERENCES

[1] A. E. Aburawi, S. Salic, M. Krampell, "New Model of Emergency Communication for Disaster Relief in Remote Areas,"12th International Conference on Innovations in Information Technology, pp 20-24, 2016

[2] Sagar Sudhakar Mane, M.K.Mokashi "Real-Time Flash-Flood Monitoring, Alerting and Forecasting System using Data Mining and Wireless Sensor Network," IEEE ICCSP 2015 conference., pp. 1881-1886, 2015.

[3] Ashida Nobuyuki, Fukui Makoto, Nasu Yasuhiro and Higashi Terumasa, "Survey of Mobile Phone Radio Waves Condition in Rural Area for Two-way Communications in Disaster," IEEE TENCON, 2011

[4] Swarnalatha Srinivas, Ranjitha P, R Ramya, and Narendra Kumar G, "Energy efficient investigation of oceanic environment using large-scale UWSN and UANETs", IJCSI International Journal of Computer Science Issues, vol. 10, Issue 1, no. 1, January 2013, pp. 566-573.

[5] Moresh M Mukhedkar and Dr. Uttam D. Kolekar, "Implementation of Real Time Secure Routing Protocol for Mobile Ad hoc Network and AES for Disaster Affected Area", IEEE 2017 International Conference on Computing Methodologies and Communication, pp. 491-496, 2017.

[6] Ranjitha Parameshwaraiah, Ramya Ramesh and Narendra Kumar G "Real-Time Underwater Communication Technique for Energy Efficient Ocean Monitoring", The Seventh International Conference on Sensor Technologies and Applications, pp. 243-253, SENSORCOMM 2013.

[7] Swapnil Bande and Prof. Dr. Virendra V. Shete, "Smart flood disaster prediction system using IoT & Neural Networks," IEEE Commun., pp. 190-194, 2017.

[8] D. Y. Dube and R. K. Munje, "Modeling and Control of Unmanned Aerial Vehicle," International Conference on Energy Systems and Applications, pp 641-644, 30 Oct - 01 Nov, 2015.

[9] Swarnalatha Srinivas, Ranjitha P, R Ramya, and Narendra Kumar G, "Investigation of oceanic environment using large-scale UWSN and UANETs", The 8th International conference on Wireless Communications, Networking and mobile computing, Sep-21-23, 2012, pp. 1-5, Shanghai, China.

[10] M. Hunukumbure, T.Moulsley, A. Oyawoye, S. Vadgama, and M.Wilson,"D2D for Energy Efficient Communications in Disaster and Emergency Situations," in Software, Telecommunications and Computer Networks (SoftCOM), 2013 21st International Conference on. IEEE, 2013.

[11] H. Nishiyama, M. Ito, and N. Kato,"Relay-by-smartphone: Realizing multihop device-to-device communications," Commun Magazine, IEEE, vol. 52, no. 4, pp. 56-65, 2014.

[12] C. H. Lee, "Wireless information and power transfer for communication recovery in disaster areas," in Proc. IEEE 15th International Symposium on World of Wireless, Mobile and Multimedia Networks (WoWMoM), Sydney, Jun. 2014.

[13] M. Li, H. Nishiyama, N. Kato, Y. Owada, and K. Hamaguchi, "On the energy-efficient of throughput-based scheme using renewable energy for wireless mesh networks in disaster area," Emerging Topics in Computing, IEEE Trans. on vol:3, Issue: 3, pp 420 - 431, sept 2015.

[14] Hui Gao, Yulong Shen and Bin Yang, "D2D Communication for Disaster Recovery in Cellular Networks," International Conference on Networking and Network Applications, 2017.

[15] Smitha Shekar B, Narendra Kumar G , Usha Rani H V , Divyashree C K , Gayatri George and Aparajitha Murali, "GPS Based Shortest Path for Ambulances using VANETs", International Conference on Wireless Networks, Vol 49, pp 190-196, 2012.