DEFIBRILLATOR DRONE

Mr. ATHARV DESAI

Department of Electronics & Telecommunication engineering

Dwarkadas J. Sanghvi College of Engineering .Vile Parle (w), Mumbai

atharvdesai1996@gmail.com

Mr. JINANG SHAH

Department of Biomedical engineering

Dwarkadas J. Sanghvi College of Engineering .Vile Parle (w), Mumbai

jinangshah2012@gmail.com

Abstract— **this document is an attempt to find a solution for the patients suffering from unexpected cardiac arrest. When the patient suffers cardiac arrest and faces intense pain, it is essential to provide appropriate panacea to prevent escalation. Expediting emergency response can reduce fatalities and reduce the medication time hysterically. An Automated External Defibrillator (AED) can augment the chances of survival of patient ten times than the prevailing percentage and can salvage the lives of many .The proposed idea is to integrate heart attack warning system and a drone with a controller. The heart attack warning system generates a warning signal before the patient is going to suffer from cardiac arrest. The controller will control the drone which has an Automated External Defibrillator (AED) attached to it. When the heart attack warning system will generate the alert signal (the patient is prone to get heart attack), this signal is transmitted to the controller. The controller in return will drive the drone to the patients GPS location. A cell phone is used to track the location of drone and the camera is used to direct the drone along its way. The controller can be in hospital or can be placed in any government building. This system of continuous monitoring the patient and sending help right in time with the help to drone can save the patient life reducing the burden on ambulances to reach on time in crowded areas. Even if the patient is not wearing the heart attack warning device the people around patient suffering from heart attack can contact the controller and drone can be driven to the patient's location.**

Keywords— **GPS/GSM tracking , Heart attack warning system, AED , segmentation, hexacopter**

I. INTRODUCTION

Cardiac arrest in medical field is known as Myocardial infarction (MI) and in worst case the patient can suffer from form acute myocardial infarction (AMI). Inspite of improvisation in medical field in past few years, probability of fatal cardiac arrest of patient is more than 0.5/1 . There is increase in mortality rate of about 22% if treatment delays by three hours of onset of symptoms compare to treatment given after one hour of onset of symptoms, and if treatment is started after three hours of symptom onset, the mortality decreases 23%.Severe Agony in chest, vertigo, giddiness, vomiting & sweating. Today's cell phone have several technologies embedded in it, so it can be used to pinpoint deterioration patient's health. A portable ECG device keeps on detecting and sending heart signals to the patient's cell phone to check vitality of it.

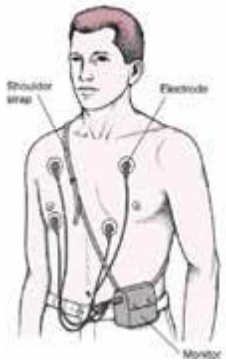


Fig. 1 Heart Attack Warning System Attached To Patient's Body.

If heartbeats show aberration from normal ones, the data will be transmitted to the nearest controller in patient's proximity. Controller along with Physicians or doctors will scrutinize the ECG Signals including P, QRS and T waves. If abrupt results are perceived by the doctors and the considering that patient undergoing heart attack and there is delay, a hexacopter drone embedded with a portable defibrillator can reach on his pinpoint location and can assist the medical treatment until the ambulance or doctor arrives. Hence the Automated External Defibrillator (AED) is attached with drone controlled by the controller is used for immediate action. This portable defibrillator consists of three stages:

1. ECG CAPTURE
2. SEGMENTATION
3. DELIVERING IMPULSE

The GPS Tracking and live video streaming in drone itself will help the doctor's to assist the person nearby the victim in treating the patient

II. HEXACOPTER (DRONE)

There has been vast technological advancement in field of multirotors. They can serve various purposes and can dispatch commodities and provide services in short period of response time.The popular Multirotors are

I. Bi-copter
II. Tri-copter
III. Quadcopter
IV. Pentacopter
V. Hexacopter

Lifesaving technologies such as an Automated External Defibrillator (AED) & Cardiopulmonary Resuscitation (CPR) are designed and dispatched by drone to required destination.
In this project , we have used

The basic mathematical modelling of hexacopter is interpreted and it is mandatory to develop design the frame of hexacopter to allow appropriate take-off weight and flight stability along with trajectory control. A hexacopter (hexa means 6) requires six fully operational rotors with ESC(Electronic Speed Control) placed at 120^0 from each other. The Mathematical modelling will accurately interpret the dynamic behaviour which takes into account the weight and internal factors as well as external forces acting on the There are several perks of hexacopter over quad and pentacopters. Some of them are elaborated below

1. Higher Payload :Since we are embedding several components to the drone.
2. Better reliability: Even if one of the rotor shuts down,the drone can still reach the destination and land safely without causing major damage to the defibrillator and cellphone .
3. Elevated Flight and Pace:Though the drone would sap greater energy compared to quadcopter, it would have higher speed and can reach higher altitudes which makes it feasible to dispatch it to location where ambulances are difficult to reach.

A set of differential equations will construe the dynamic behaviour of the drone during its flight can be derived from the Newton-Euler equations or from Quaternions

BASIC MATHEMATICAL MODELLING:

The oblique acclimation of the hexacopter frame can be interpreted by 2 computation techniques:

1. NEWTON-EULER EQUATIONS
2. QUATERNIONS

Here we use NEWTON-EULER computation equations to define takeoff weight and RPM of hexacopter (i.e reference) frame to earth which is considered as fixed frame .

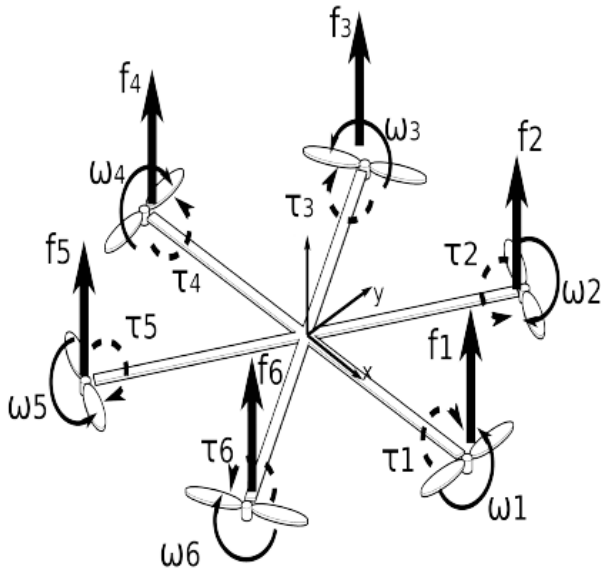


Fig. 1 Hexacopter with torque and forces acting on rotors

The hexacopter frame (Ax, Bx, Cx) is the body fixed frame & it acts at the center of gravity(COG) of hexacopter. The earth is speculated as inertial frame and the exact topography of hexacopter(a, b, c) is evaluated accordingly. Let the three Euler angles be defined as roll (β), tilt (α) and deviate (γ) angles.The mathematical relation between the hexacopter which acts and as body frame and earth which is inertial frame is obtained by rotation matrix R

$$\begin{bmatrix} \cos\alpha\cos\gamma & \cos\gamma\sin\alpha\sin\beta - \cos\beta\cos\gamma & \cos\beta\cos\gamma\sin\alpha + \sin\beta\sin\gamma \\ \cos\alpha\sin\gamma & \cos\beta\cos\gamma + \sin\alpha\sin\beta\sin\gamma & \cos\beta\sin\alpha\sin\gamma - \cos\gamma\sin\beta \\ -\sin\alpha & \cos\alpha\sin\beta & \cos\alpha\cos\beta \end{bmatrix} \quad (1)$$

And the following matrix will give the relation between angular velocities of inertial and body frame cardinal to provide stable flight.

$$W_\eta^{-1} = \begin{bmatrix} 1 & \sin\beta\tan\alpha & \cos\beta\tan\alpha \\ 0 & \cos\beta & -\sin\beta \\ 0 & \sec\alpha\sin\beta & \cos\beta\sec\alpha \end{bmatrix} \quad (2)$$

In this project we would require to calculate the maximum takeoff weight that can be lifted by hexacopter because of defibrillator annexed to the frame. Equation below shows force which acts on the frame

$$\text{Force } F = \frac{d(mv_B)}{dt} + v \times (mv_B) \quad (3)$$

M=constant mass

T_B is the total thrust

$$T_B = \sum_{i=1}^{6} f_i = k \sum_{i=1}^{6} \omega_i \qquad (4)$$

Considering the effect of gravitational force ,equation of total force will be given by the expression:

$$F = Q^T F_{g+} \; T_B \qquad (5)$$

the translation component of the motion referred to the body frame is

$$m\,\dot{v}_B + v \times (m\,v_B) = Q^T F_{g+} \; T_B \qquad (6)$$

The hexacopter frame will have only translational motion and no rotational motion and so its centrifugal force can be eliminated.

Thus we have analysed the various forces acting on body frame and so we can design the frame with appropriate distance between the rotors and battery source for successful aviation with defibrillator

III. HEART ATTACK WARNING SYSTEM AND THE CONTROLLER

Fig. 3 Block Diagram Of Heart Attack Warning System

As shown above , ECG signals of patients with high risk are constantly monitored. The aberrant ECG signal can be sent to the controller of drone. ST Elevation can be detected using different mechanisms. Just to show how the ST elevation is detected in the heart attack warning system we have took the paper on "Real Time Recognition of Heart Attack in a Smart Phone" as a reference in which detection of the ST elevation is done by taking R-wave as a reference. R-wave detection can be done by using various methods. One of the method is by using hilbert's transform.

Threshold value needs to be evaluated to find the risk level in the ST elevated signal.

The section between the QRS complex and the T-wave in the heart signal is the ST segment and the base line signal is harmonized with it.

Fig. 4 NORMAL AND ST ELEVATED SIGNAL

The primitive indication of cardiac arrest is the spike that is observed of ST segment. If the magnitude of ST segment exceeds above 0.1 mV, then the ST segment is addressed as ST-elevation. Thus from the magnitude of ST segment obtained we can determine the presence of ST elevation. Therefore the controller and doctors can be acquainted with the critical condition of patient on obtaining the ST elevation..The Elevation segregates the output of this stage into 3 levels

1. 0.1 < output < 0.5 -Green light is flashed
2. 0.5 < output < 1 - yellow light
3. 1 < output - red light is (The patient is discerned about the risk)

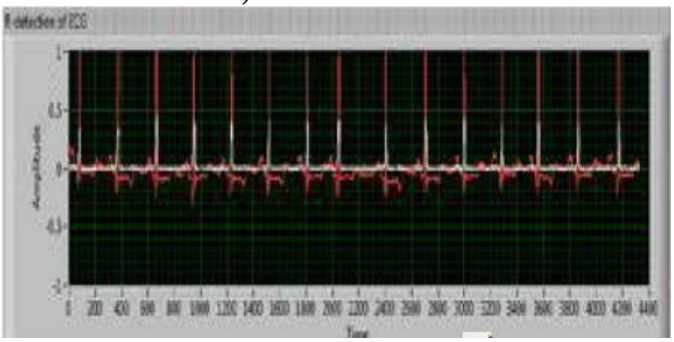


Fig. 5 R-Peak Detection

The results mentioned in the figure no.4 is also took from paper on "Real Time Recognition of Heart Attack in a Smart Phone".

IV. AUTOMATED EXTERNAL DEFIBRILLATOR

AED is a portable defibrillator. Any AED can be attached with the drone. The defibrillator analyses the ECG waveform. It has trivial weight compared to those used in hospitals. Being transportable, it discharges high electric voltage through the heart and diaphragm.. A pre-programmed built-in computer monitors the heartbeats through adhesive electrodes.Doctors & Instructors will guide the rescuer through the smartphone attached to the drone. AED provides accurate medication to Ventricular Fibrillation and Pulseless Ventricular Tachycardia.

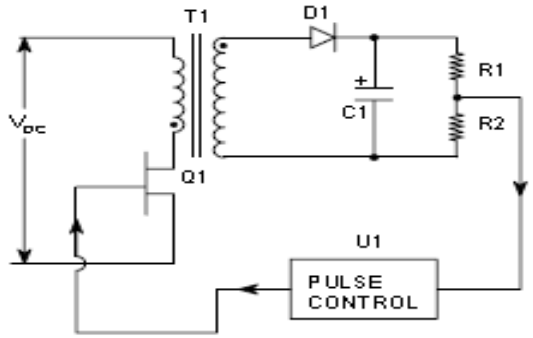


Fig.6 Asynchronous Defibrillator With Pulse control

Shown above is the block diagram of asynchronous defibrillator. Here the Pulse control acts as feedback element. When a person suffers cardiac arrest,it is imperative to

interpret what magnitude of shock should be discharged across the capacitor C1. Pulse control does the task of identifying the magnitude of pulse detected in patient's body.this is done by Capturing of ECG and Segmenting is accordingly.

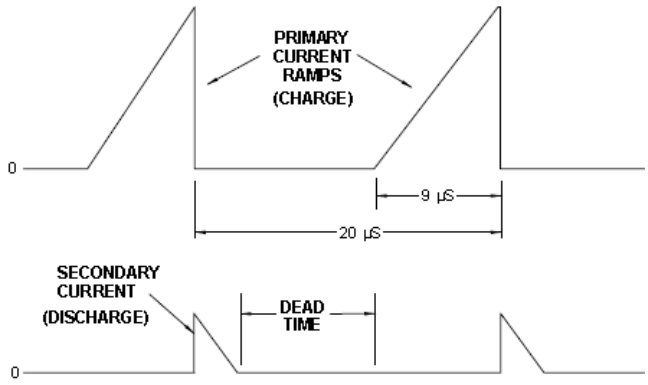


Fig. 7 Charge/Discharge Of Capacitor Across Pads

Since the battery used in AED's are also replaceable there is no need of external mains supply to charge the capacitors.

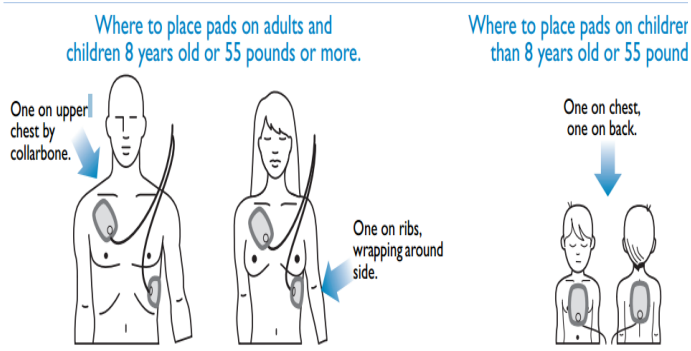


Fig. 8- Placement of pads of AED.

AED's firsts analyses the ECG obtained from the patients body and then analyses it. If shock is required then the AED will deliver a shock pulse. It also guides to perform Cardiopulmonary resuscitation (CPR).

Advantages of using AED:-

1) During cardiac arrest (SCA),patient gets high discharged voltage through an AED within the first minute, the survival rate is 90%.

2) 30% - 50% of SCA victims would survive if AEDs were used within five minutes.

3) All AED devices have voice prompts, enabling untrained bystanders to easily administer therapy with an AED.

V. Embedding Smartphone In Hexacopter:

Because of syndicate features performed by cellphone,we have decided to entrench a lightweight android OS cellphone in hexacopter.

The main functions performed by it are:

1) GPS & GSM Tracking: To track the exact location of the drone and the distance from the victim suffering cardiac arrest,the cellphone attached to drone is tracked via internet using Open GTS/GPRMC standards.As a result, the GPS(Global Positioning System) module of mobilephone gets interfaced to personal computer of controller. Android application 'FOLLOWMEE' is used. This will enable the controller to track the current location of drone on computer and direct it to the vital destination.

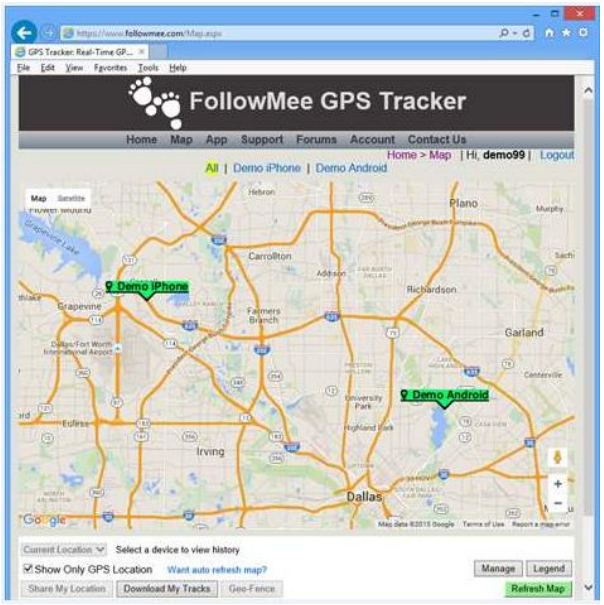
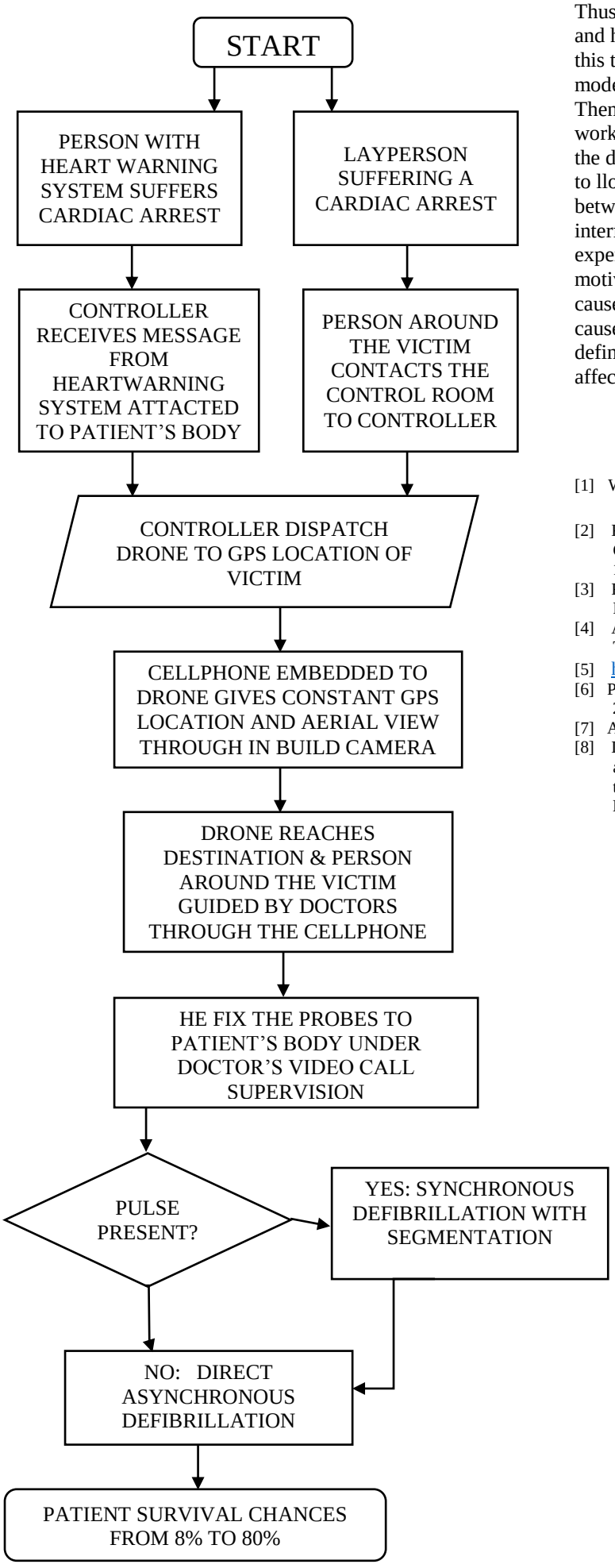


Fig. 9. GPS Location Of Droe On PC Of Controller

2) Live Video Streaming: To provide aerial view of drone and also to escort the person around the victim in operating the person, live video streaming is mandatory and so the same cellphone is used instead of separate video camera to suffice this function.

3) Controlling Of Drone: Flight controllers act as the heart of the drone. It is responsible for sending the control signals to the ESC(i.e electronic speed control) for controlling the RPM of motors to direct the drone in particular direction. The flight controller is basically an example ASIP embedded system and so it is customizable. As a result android phones can be connected to flight controller and can generate control signals using several android applications. Due to the capability of smartphones to work as radio receiver, they can to used to control the drone instead of using separate RC remote .

VI. FLOW CHART OF PROJECT



VII. CONCLUSION

Thus we have expounded our idea of integrating Defibrillator and heart attack warning system into our hexacopter drone. In this technical paper we have interpreted the mathematical model with equations to design the drone to suffice our needs. Then we have explained the underlying principle and basic working of heart attack warning system and also deciphered the designing of defibrillator along with its three stages. Also to llocate the drone and to enhance the communication between the the doctors and layman in treating the victim,we interfaced a cellphone to the drone instead of using separate expensive video camera and GSM /GPS module .The motivation behind this project is the catastrophic statistics caused by heart attack across the globe.In India ,a casuality is caused every 33 seconds. Implementing this project would definitely reduce medication response time which is adversely affected by serious traffic congestion in cities.

REFERENCES

[1] W. F. PHILLIPS (2004) MECHANICS OF FLIGHT, (JOHN WILET & Sons)

[2] Kasper Dennis L, Fauci A, Braunwald E. 16th ed. New York: Mac Grow–Hill; 2005. Harrison's principles of internal medicine; pp. 1425–1430.

[3] R. F. Stengel (2004) Flight Dynaimcs, (Princeton University Press).

[4] A. P. Yefremov (2004) Quaternions: Algebra, Geometry and Physical Theories, Hypercomplex Numbers in Geometry and Physics 1

[5] http://www.aedprofessionals.com/

[6] Pressman, A.I., 1998, Switching Power Supply Design, 2nd Edition, McGraw-Hill, ISBN 0- 07-052236-7

[7] ACTA INFORM MED. 2015 JUN 23(3): 151-154

[8] Li X, Wang T, Zhou P, et al. New Jersay: 2003. ST-T complex automatic analysis of the electrocardiogram signal based on wavelet transform, Proceedings of the IEEE 29th Annual Northeast Bioengineering Conference