Drowning detection system using GSM and Remote Alert

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***Abstract*— Drowning has been a major global injury issue and is the second largest explanation for accidental injuries and deaths, only after accidents because of road traffics. It accounts for 3,20,000 cases yearly and a major cause for accidental death globally. The security of swimmers is the primary concern. In order to achieve this, efficient drowning detection systems are essential. As a consequence, numerous inventions to stop drowning and to rescue drowning victims are remodeled over the years. Comprehensive study of drowning detection and prevention strategy are the major focus of this paper. Numerous method and innovative technologies have been proposed to improve pool safety. Many concepts have been accepted to detect drowning. Some of the widely preferred concepts are Heart beat sensing, Motion sensing, Image processing etc. The paper will be an amalgam of innovation and traditional techniques. These systems could be life saver for a person drowning. The proposed drowning rescue systems aims to curb deaths from drowning by observing the rise and fall of the heart rate and also by using other parameters of a swimmer or non-swimmer in water and if threatened, many of the techniques prefer transmitting signals from the wireless device attached to the wrist or on the other parts of the body of the sufferer who might be drowning. The signal received by the receiver can be sent to lifeguard, parent, poolside workstation or neighbor, in directive to authorize the rescuer will furnish immediate help. In addition, to the proposed solution we used GSM technology to establish the data link. This device transfers real time data in case the threshold is crossed.**

***Keywords*: Heart beat sensing, motion sensing, image processing, GSM, AT mega 328Microcontroller, buzzer, LCD display**

I. INTRODUCTION

Safety in water has been compromised in the past and survival of human life has been at risk, especially when it comes to non-swimmers. Drowning is far and away the foremost devastating sort of losing the life, because it takes the victim to the jumbled state of trying to get some air for breathing and at same time not allowing the water to enter into the lungs. Drowning takes place in variety of water bodies such as oceans, dams, reservoirs, water tanks, streams, tarn, irrigation channel. There have been cases recorded of infants drowning in Bathtubs too. Drowning is one among the foremost dreadful and unpredicted explanation for loss of life till date amongst all age groups.

If we consider death due to drowning, it accounts for 7% in overall injury related death and it is also considered the 3rd major source of unintentional death. There is an estimation of 3,20,000 annual drowning deaths worldwide [1]. Global estimates may significantly underestimate the particular public ill health associated with drowning. Children, males and individual have more risk of drowning. The age is one of the main risk factor for drowning which is announced by the global report conducted in 2014 regarding drowning. This relationship is usually related to a lapse in supervision. Around the world, the rate of drowning is higher in children categorized of age 1-4 years followed by children aged 5-9 years. The frequency of the death of children aged 5-14 years are more in the WHO western pacific region than any other cause. On an average an adult can hold a breath for about 2 minutes where as a 4-year kid could hold for very less duration.

The statistics shows that males are in higher danger of drowning than twice the general death of females. The probability of male to be hospitalized for less fatal drowning is higher. It reveals that the elevated rate of drowning among males are because of their increased subjection to water and riskier conduct, like swimming alone, drinking alcohol before swimming alone and boating. Increased eruption of water is another probability factor for drowning. Drowning accounts for 75% of deaths in flood disasters [1].

The factors influencing the risk of drowning are as follows:

- Lack of education, lack of proper guidance, lack of discipline near water bodies;
- Lack of monitoring of infants;
- Consumption of Alcohol, near the water or while swimming;
- Medical conditions, such as epilepsy;
- Tourists unacquainted with local water risks and features;

Drowning is divided into five stages [2]:

A. ***Shock:*** In the starting stage the person is under a state of shock, difficulty in breathing follows. The person starts to make a desperate attempt to reach the surface.
B. ***Reflexive Holding of breath****:* Here, fatigue strikes the person and he desperately tries to hold the breath. The person drowning will become unconscious and he stops breathing.

C. ***Unconsciousness:*** The sufferer loses consciousness, and starts to sink.
D. ***Hypoxia:*** It is a condition of absence of enough oxygen to sustain bodily functions. There is a lack of supply of oxygen to brain.
E. ***Death:*** Death is followed.

Keeping this view, many such attempts has been made to avoid drowning and have been given several thoughts over past years. But nowadays anti-drowning measures can be summed up around the heartrate of the individual. This gives us a better probability to save life of a concerned person. However, since the life of a person is of most concerned here, conventional process can be changed a little bit for a more effective and risk free saving of life; since every person has different survival instincts, the period of drowning plays an important role here. To conclude this, if someone is saved under some given passage of time, anti-drowning system would have served its purpose very well.

II. DESIGN OF THE MODEL

The design of the drowning alarm system is based on the heart rate pressure theory. The system has two fundamental modules: the bracelet that looks like a watch with a transmitter side cardiac pressure sensor and a Microcontroller, whilst the receiver end that is supported by the lifeguard is made up of a second microcontroller, a buzzer and an LCD display [4]. Individuals that join the pool would wear the bracelet which would always be left on. The heart rate pressure would be determined at a certain high and low level to signal when there is a real hazard. Once the person enters the pool, the pressure of the heart rate is detected and monitored continually by the cardiac rate sensor attached to the microcontroller. If the current value exceeds the threshold, an alarm signal is sent to the recipient that serves as the lifeguard. Wireless signals are sent and received by an RF module [5]. The system puts the buzzer on after receipt of the valid signal microcontroller, which seeks to prevent fatalities from drowning by indicating an impending threat to the lifeguard so that he may save the victims before they die.

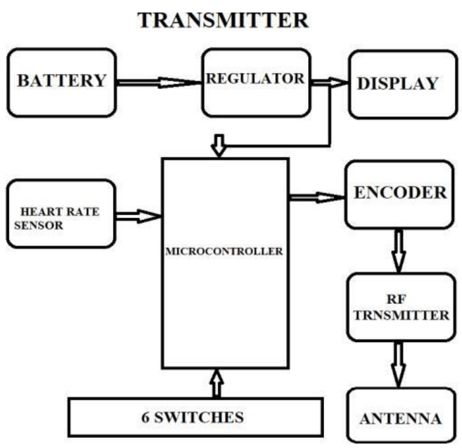

Fig 1 Block diagram of Transmitter.

In this system the heartbeat sensor which is used to monitor the heart beat rate of the person. The information that is transmitted through GSM coordinator ranges from 930 to 960MHz. When it is under water the range is around 2 to 4 meters. On the other side the receiver circuit is provided with the lifeguard that is used to collect information about the heart beat rate of a person. This happens while the transmitting circuit is with the person under the water [13]. The transmitter circuit has the AVR family microcontroller which is been interfaced with the LCD display. This is used to display the heart beat level of a person who is in danger to the lifeguard on the receiver side [8]. The transmitter circuit is thus powered by 12V battery, whereas the receiver circuit is also included with a AVR family microcontroller and the GSM router which is powered by a 12V transformer/Adaptor.

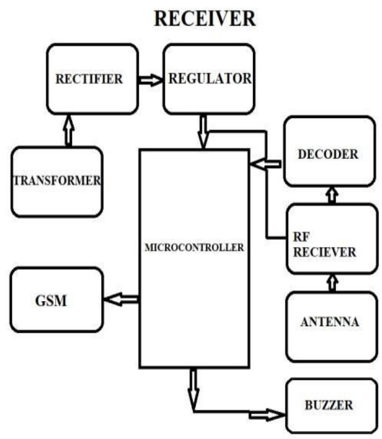

Fig 2 Block diagram of Receiver.

The heart beat sensor was mounted either on the head or the hand of the person inside the water that helps to track also attached with the system. These LED light and buzzer gets turned ON when a person's heartbeat level is higher or lower than the normal condition. When this happens the buzzer gets ring and also the LED light gets turned on [6]. Thus the lifeguard get the signal more effectively even if he fails to observe the LED glowing [9]. This idea is also modified and extended by attaching GSM module to both the transmitter and the receiver blocks so that it also sends message to the mobile of the lifeguard and to the family members.

III. SOFTWARE REQUIREMENTS

- **INTRODUCTION TO AVR Studio 5**

AVR Studio 5 is a free integrated development environment (IDE) for programming Atmel's AVR microcontrollers, including the 8-bits, 32-bits, and ARM Cortex-M families. AVR Studio 5 has built-in support for AVR ISP programming and works with the WinAVR avr-gcc compiler [10].

It's a complete software development environment that includes an editor, a simulator, and a programmer, among other things.

The AVR GNU C Compiler, which is included, is a built-in C compiler (GCC). As a result, you won't need to use a third-party C compiler.

It offers a single environment for developing programmes for microcontrollers in the 8-bit, 32-bit, and ARM Cortex-M AVR family.

- **KEIL CROSS COMPILER**

Win AVRTM (pronounced "whenever") is a collection of open source software development tools for the Atmel AVR line of RISC microprocessors that run on Windows. The GNU GCC compiler for C and C++ is included.

All of the tools for development on the AVR are included in WinAVRTM. Avr-gcc (compiler), avrdude (programmer), avr-gdb (debugger), and more programmes are included. WinAVR is utilised in a wide range of applications, from hobbyists in wet basements to schools and business enterprises.

WinAVRTM is made up of a number of open source projects. Volunteers are always welcome to assist with bug fixes, feature additions, porting, producing documentation, and a range of other activities on a range of projects if they feel so inclined.

IV. BUILDING AN APPLICATION IN AVR STUDIO

To create (compile, assemble, and link) an application with AVR Studio, you'll need to do the following:

1. Choose a project first.

2. Choose either Build - Rebuild all target files or Build target from the Build menu.

3. The files in your project are compiled, assembled, and linked by AVR Studio.

V. CIRCUIT DIAGRAM

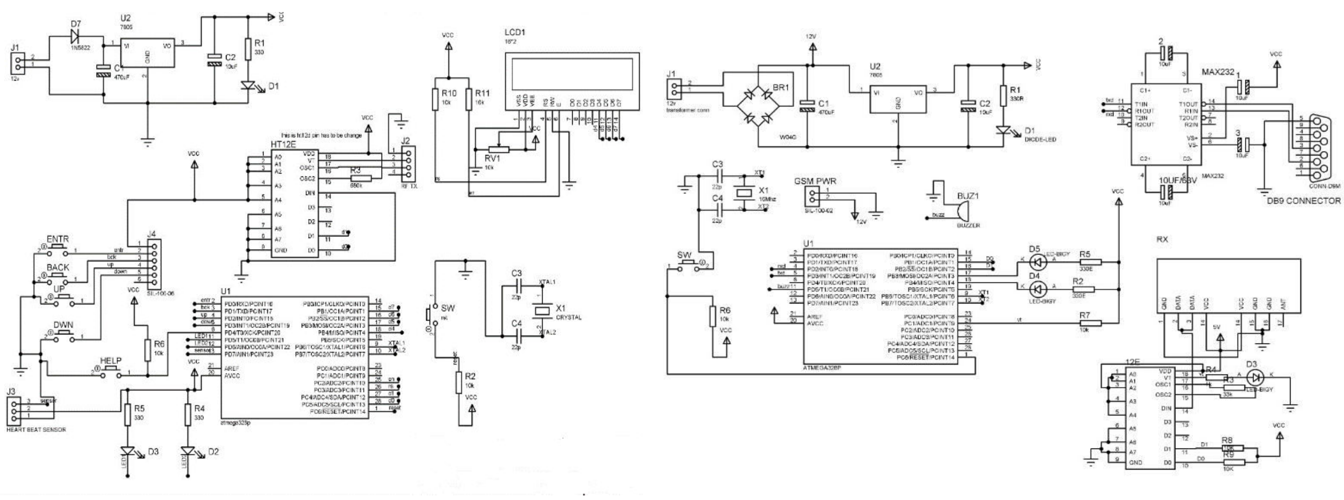

Fig 3 Circuit diagram of transmitter and receiver.

Conventional devices use RF frequency and works with RF transmitter and receiver. The proposed system is works with the RF module where we can use a RF module and thus can provide a multi user interface[11].

The transmitter block consists of battery, RF module which further has an encoder and transmitter, LCD, push button switch, Reg ulator IC and heart sensor. Battery used here is rechargeable battery i.e. when the main supply is ON the battery chargeto its full capacity and during power failure the battery is used as a power backup. Thus, the battery can be recharged a number of times. To rectify and get a constant voltage in spite of fluctuations in main supply we use here a 7805 voltage regulator IC. Push button switches are used to set the limit for pulse count i.e. upper limit and lower limit. Depending on these limits the buzzer at receiver rings [3]. LCD is used to display the limit values.

The receiver block consists of a RF module, buzzer, microcontroller, transformer, rectifier and regulator. Similar to transmitter block receiver also has the same components barring a few changes. RF module here decoder and receiver to receive RF signals. Here we however use a 12-0-12 V transformer which is connected to 230V mains supply [7]. Like transmitter here also we have rectifier and regulator IC for constant output voltage. The most important part of receiver block is buzzer used to indication emergency condition of swimmer and also LED is connected in case if buzzer fails. The AT mega 328 microcontroller is the main heart of the system. It is common to both transmitter as well as receiver [12]. It will process all our signals and function as per the user requirement. ATmega88 and ATmega328 support a real Read-While-Write Self-Programming mechanism. There is a separate Boot Loader Section, and the SPM instruction can only execute from there. In ATmega48, there is no Read-While-Write support and no separate Boot Loader Section. The SPM instruction can execute from the entire Flash.

VI. IMPLEMENTATION AND TESTING

For the control of the complete drowning rescue system, an ATmega328p microprocessor was employed. The ATmega328 chip was utilised in this project and was put on two distinct Arduino boards, one for the transmitter and the other for the reception. As a result, the Arduino 1.8.5 IDE is utilised, which is an open-source Arduino software (IDE) with a java-based environment that allows you to build C-language programmes and simply upload them to any Arduino board.

- **ACCEPTANCE TESTING**

The transmitter strap module was put on an individual's wrist after the Drowning rescue device was constructed, and it needed a few moments to settle before it began beating in line with the individual's pulse. When the transmitter strap module detects an irregular pulse beat (above or below the threshold), it transmits a signal to the receiver or lifeguard module, which is displayed on the LCD and audible via the buzzer.

- **PROGRAM TESTING**

Following the development of the programme codes, the code was compiled to ensure that there were no build issues or problems. The sections where there were issues, such as the RF module header not being called correctly, were fixed and rebuilt, after which it was successfully compiled.

- **UNIT TESTING**

Before soldering on the Vero board, each of the drowning rescue system components was examined with a digital multimeter to ensure that they were indeed operating.

- **SUBSYSTEM TESTING**

This test was carried out as part of the Drowning Rescue Device's steady development, with the pulse sensor device being tested with the Arduino to ensure that it was responsive, as well as the RF module on the Arduino's to ensure that the data being provided was also being received. Following that, all of the components were soldered to the Vero board and examined for regularity. Although the circuit design was initially evaluated on breadboards to see if there were any flaws, to ensure proper component and subsystem placement, and to assess current and voltage consumption.

- **SYSTEM TESTING**

This test comprised evaluating the whole drowning rescue system, and it was here that several faults were uncovered, such as the fact that the RF transmitter required a higher voltage source in order to broadcast, since it had previously shared a voltage source with the pulse sensor and the microcontroller. The RF transmitter's voltage source was thus distinguished from the pulse sensor's voltage source.

VII. RESULTS

1. As soon as the system boots up, you'll see two choices on the screen: start and settings.
2. By hitting the up and down keys and then hitting enter, we may choose any of the options.
3. The system will go into operation mode if we choose the start option.
4. The sensor must be worn in the index finger of the user's hand before entering operating mode.
5. When the operating mode is switched on, it will take a few moments to initialise before displaying the pulse rate (i.e pulse per minute).
6. There are two methods for detecting the destress signal while in operating mode.
   a. Manual destress: If the user is distressed, he or she may press the help key for a long time (a few seconds), which will send a help signal to the receiver, which will then activate the buzzer.
   b. Automatic destress: This signal is sent when the detected pulse falls out of the rang, at which point it sends a signal to the receiver.
7. To return to the menu from any destress status, the user must use the back key.
8. Setting is the second item in the menu, and it allows the user to customise the heartbeat ring.
9. When in setup mode, the user may first pick the lower limit of the heart beat rang by pressing the up and down keys followed by the enter key.
10. After entering the lower limit, the system will present the higher limit option, which is done in the same way as the lower limit selection.

the eleventh The system will return to regular operating mode once the top limit is reached.

VIII. CONCLUSION

Drowning is the third greatest cause of accidental death globally, affecting swimmers, accident victims, youngsters, and people seeking leisure activities. Despite the fact that some countries have put in place several measures to avoid drowning, it is still the top cause of accidental death. Except in undeveloped nations where there are inadequate educational facilities and enforcement of safety measures on the risks of drowning, eradication rather than treatment has been able to decrease the number of persons who drown, thereby raising the burden of drowning. Thus, the drowning rescue system was created to prevent drowning deaths by monitoring the rise and fall of a swimmer's or non-heart swimmer's rate and blood pressure in water and, if the victim is in danger, sending signals through a wearable device attached to the victim's wrist to the receiver or rescuer, who may be a lifeguard, parent, or neighbour. GSM module is installed to retrieve the victim’s status. The SMS will send to the right person or authority so that the person who is drowning might be rescued. There is a “HELP” button provided in the transmitter. When the person starts to feel uncomfortable he/she can press that button which sends the SMS to the concerned authority as well the buzzer will be ON so that the person can be saved.

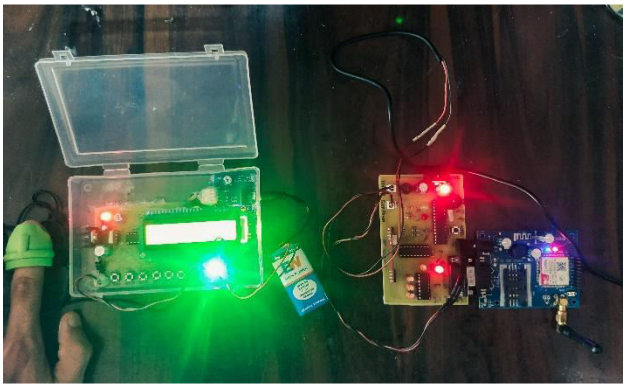

Fig 4 Drowning detection system.

IX. FUTURE SCOPE

We conclude that the area of "Anti-Drowning Systems" is an important part of human safety and security, and that it contributes significantly to the creation of smart systems that can save people who are drowning. Despite the fact that much of the work done so far has concentrated on the identification and intimidation of drowning victims, it falls far short of what is needed. As a result, a system that detects drowning, takes proper action to rescue a person, and records such occurrences while relaying information to the necessary people might be developed. A smartphone app may be developed to allow the underwater wearable to tailor each swim experience while also sending data to the surface in real time. GPS services might be utilized to convey geographical location information about a drowning incidence to nearby coast guards, allowing for professional aid and the recording of drowning incidences.
This might lead to a dramatic change in present anti-drowning technology, and hence in Human Safety and Security. The annual death rate due to drowning occurrences might be reduced dramatically with the help of this dynamic system, which might become an integral part of diving and swimming-related activities in the future.

REFERENCE

[1] "Drowning", Who.int, 2020. [Online]. Available: https://www.who.int/news-room/fact-sheets/detail/drowning [Accessed: 03- Feb- 2020].

[2] 5 Stages of drowning http://www.dedhamhealthfoundation.org/water/victimrecognition/stages-of-drowning/ Jul 2018.

[3] A Kanchana, Kavya G.R, Kavitha C, Soumyashree V, Salila Hegde, 'Automated Drowning Detection And Security In Swimming Pool', Irjet, Volume: 04 Issue: 06 | June -2017

[4] Lince Mathew, Anumol Thomas, Bency Baby, Chinnu Stephen, Jincy E. Eldhose, 'Adrs (Automatic Drowning Rescue System For Human Using Rfid)', Irjet, Volume: 04 Issue: 04 | Apr -2017

[5] K. Aditya Pratap, S.Roji Marjorie, 'Anti Drowning System With Remote Alert Using Zigbee', Ijpt| Dec-2016 | Vol. 8 | Issue No.4 | 20523-20527

[6] Nasrin Salehi, Maryam Keyvanara, Seyed Amirhassan Monadjemmi, 'An Automatic Video-Based Drowning Detection System For Swimming Pools Using Active Contours', Doi: 10.5815/Ijigsp.2016.08.01

[7] S.Hemalatha, P.Nandhini, J.Vimala, V.Ramesh, 'Automated Drowning Detection And Security In Swimming Pool', Ijircce, Vol. 3, Special Issue 2, March 2015

[8] S.Nagalikitha, A.V.Kiranmai, 'Automatic Waist Airbag Drowning Prevention System Based On Motion Information Measured By Memos Accelerometer And Pressure', Ijeter, Vol. 3 No.6, Pages : 204- 206 (2015)

[9] Wai Kit Wong, Joe How Hui, Chu Kiong Loo and Way Soong Lim, "Off-time swimming pool surveillance using thermal imaging system", International journal of innovative computing, information and control, vol. 9 (3), 2013, pp. 366-371

[10] Chi Zhang and Xiaoguang Li, "A Novel Camera-Based Drowning Detection Algorithm", Proceedings of Advances in Image and Graphics Technologies, Beijing, China, June 2015, pp. 224-233

[11] Lei Fei, Wang Xueli and Chen Dongsheng, "Drowning Detection Based on Background Subtraction", International Conferences on Embedded Software and System, 2009, pp. 341-343

[12] Alvin H. Kam, Wenmiao Lu and Wei-Yun Yau, "A Video-Based Drowning Detection System", Proceedings of the 7th European Conference on Computer Vision-Part IV, Copenhagen, Denmark, May 2002, pp. 297-311

[13] Bhavesh Dhande, Yash Kothawade, Abhishek Kulkarni, Anjali Askhedkar "Comprehensive Survey of Drowning Detection and Rescue Techniques" International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056 Volume: 05 Issue: 03 | Mar-2018 p-ISSN: 2395-0072