

# SMART SHIRT - A New Dimension towards Wearable

Shaveta Bhatia, Sonali Chopra, Juhi Pandey, Nikita Yadav

**Abstract:** In ancient time, when there were no technologies and no smart devices were available, humans did all their tasks manually which was time consuming and also challenged their physical and mental health. Then invention of basic devices such as desktop computer, calculator, Abacus made their life easier. Also it reduced their work load and saved their time and efforts. The major problem with these devices were that they occupied a large space and also they it was difficult to move them from one place to another.

Humans are now becoming dependent on machines for their work. And this is what led to the invention of more compatible devices which are in small sizes and are easily portable. Laptops, smart phones, tablets are some devices which provide more advantages over desktop computers and calculators. They contain integrated chips, sensors and actuators to perform functionality.

In today's world technologies are becoming the most important part of human life. We are always surrounded by some kind of technology. It can be a smart phone, laptop, smart television, automatic cars, computer, and many more. The development in technologies over past few decades completely changed the human lives. It also made a great impact on business world and provided a platform to e-commerce which is one of the most successful technologies nowadays. There are so many advanced technologies making humans life easier and comfortable day by day. One of them is wearable technology or a wearable device makes human life easier by providing computational functionalities and features.

**Keywords:** desktop computer, calculator, e-commerce

## I. INTRODUCTION

A large number of new applications in the wearable space will be enabled through the advances in low power chip design. Wearable is what we can wear. A smart wearable approach leads to a strong computing ability. It is relatively seamless integration between wearing and computing i.e. not just taping a computer to our body. Most likely the advancements in low power chip design will have a profound influence on healthcare. The technology of fitness wearable is now working via our clothing rather than wrist straps of practical jewelry. Now a days we have a number of products which allow you to track numerous parts of your exercise routine, all through the materials you are wearing. It can be a shirt which is keeping an eye on your heart rate or it can be a pair of trousers that monitors your running form and gait, there's an item of clothing for your workout.

**Revised Manuscript Received on July 20, 2020.**

**Shaveta Bhatia**, Professor, FCA, Manav Rachna International Institute of Research and Studies, Faridabad, Haryana, India.

**Sonali Chopra**, Student, FCA, Manav Rachna International Institute of Research and Studies, Faridabad, Haryana, India.

**Juhi Pandey**, Student, FCA, Manav Rachna International Institute of Research and Studies, Faridabad, Haryana, India.

**Nikita Yadav**, Student, FCA, Manav Rachna International Institute of Research and Studies, Faridabad, Haryana, India.

The best thing in this is that you are no longer needed to keep a check on your mobile phone or smart watch. You can easily focus on what you're doing rather than preparing smartphone apps or devices beforehand. For now, this smart clothing is very expensive and it costs a lot more than the regular gym or sportswear, but it's worth investing on some new grab. In some cases, it almost replaces the need for a dedicated trainer, depending on the type of workout you're embarking on.

Wearable devices are the computer devices which act smart and are worn by the user on their body. These devices contain sensors and actuators to provide facilities and perform functionality. Spy cameras, video recording devices, fitness bands, smart watches these are the some examples of wearable devices which have totally changed the era of digital world.

This article is about the study of wearable technologies with its history and future. Also we will see the study about its feature, applications, and the architecture. Further in this article we will analyze the features, working, and results produced by using a smart wearable i.e. Smart shirts.



Fig.1 Smart Shirt Design

## II. EVOLUTION OF SMART DEVICES AND WEARABLE TECHNOLOGY

### A. History

Materials to create such a thing has been around for centuries. (For example: Queen Elizabeth had gowns made of gold fibers). Harry Wainwright was the first to create an "animated shirt" where a microprocessor controlled the individual frames creating a cartoon on the surface of the textile. MIT took the next step towards the "wearable motherboard" in the mid 90s.

However this didn't amount to more than simply attaching traditional hardware to the body (failed our goal of seamless integration and aesthetics).

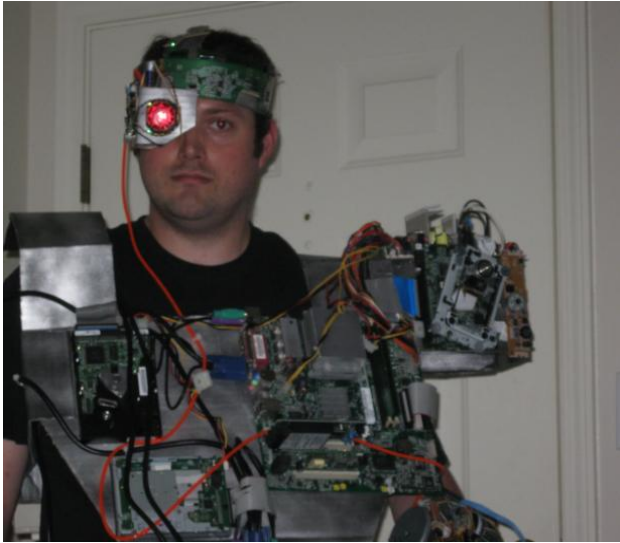


Fig. 2. Cyborg costume

## B. The present

Further steps have been achieved to “seamless integration” thanks to Sundaresan Jayaraman and Georgia Tech. His findings have the most application and depth. Other companies such as OMSignal and Hexoskin have created their own e-textiles focusing more on aesthetics and fitness applications. For the sake of broader understanding, I'll be using Dr. Jayaraman's “Wearable Motherboard”.

## III. ARCHITECTURE

### A. Networking and communication

In this where data acquisition from many sensors is involved. Issues such as addressing of the individual sensors, the layout of the data paths within the fabric. The placement of the processing units and the routine strategies all play a significant role in the design of the fabric. In terms of its power consumption.

### B. Interconnection

This might be one of most difficult areas dealt with in the electronics industry and interconnection involves either connecting two wires or connecting an electronic component to a wire. The common method that is used for both these interconnections is soldering. Components can also be connected to the wires using insulation. Displacement connectors and spot welding on the other hand stitching interconnects two pieces of fabric. When two pieces of E-textiles have to be interconnected both these issues have to be considered simultaneously. Thus there is need to develop interconnection between electronic components and textile.

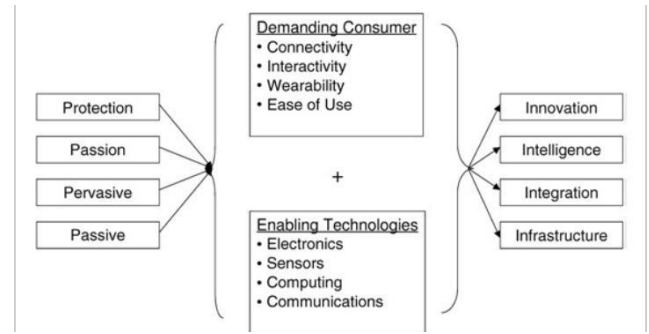


Fig. 3. The demands of today's consumers coupled with advances in enabling technologies are transforming textiles from their traditionally passive role into a new interactive one.

### C. Power supply

The power supply is the biggest problem. Power supply technologies typically batteries provide the electrical power for activating components in an electronic textile. In recent years, batteries have not only become smaller and more powerful water resistant and lower cost. One type is fabricated by screen printing silver oxide based paste on a substrate to yield battery only 120 microns thick, solar energy and energy created by the human body are also being studied as sources of electrical power for electronic components. Two of the most known approaches to develop new power supply technologies, are lithium polymer battery and micro fuel cells. Sunlight, body temperature and body motion are alternative energy sources on the body that can be transformed into electrical energy. Also in this case, one should differ between flexible and textile, because there are more efforts to mount flexible energy supplies onto textiles than inventing pure textile power supply.

Thin film solar cells can be made on flexible surface technology has also been adapted to fiber form. The efficiency of these alternative energy sources needs to be improved.

## IV. TWO MAJOR COMPONENTS

Sensors acquires the raw data from the user and it's environment. Provides a context. Signal Processors takes data from sensors and computes them into something appropriate to the context. For example biometric data from the sensors is computed into heart rate or body temperature. This data is then usually transmitted to somewhere else.

### A. Sensors

Core piece: Carbon fiber. Tears in this fiber will be recorded, as we'll see later has variety of applications for people in dangerous environments. Rest is up to the user's required function, “plug and play model. Includes slot for microphone. For example, hospitals attach the very same sensors they use on patients to measure heart-rate, respiration, EKG, body temperature, and pulse oximetry (SpO2). Allows to retrieve the same accuracy of data from afar.



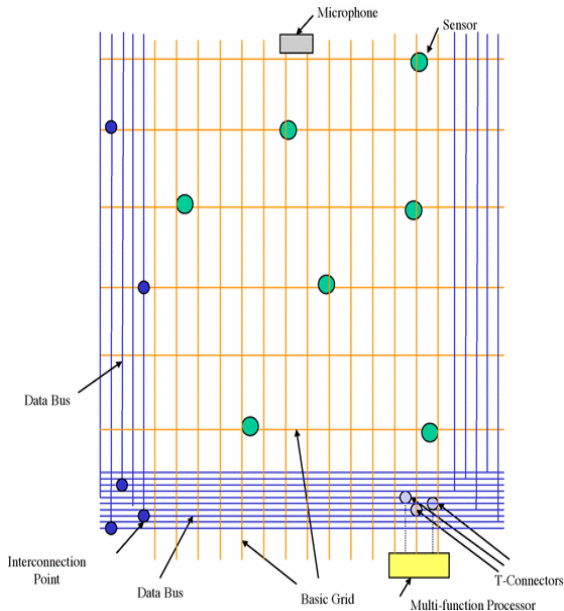


Fig. 4. Sensors

**B. Signal Processing**

This is how the data is sent from the shirt to afar. The data is integrated into the data bus and transmitted to the multifunction processor known as the Smart Shirt Controller. The controller then takes this data and transmits it wirelessly via Bluetooth, Wi-Fi, or cell data. Data can also simultaneously be transmitted to the sensors. The sensors that can be integrated are completely open ended. For example, a sensor that can detect outside O2 levels or hazardous gas could be utilized in a smart shirt for Firefighters. This opens up a whole market for development.

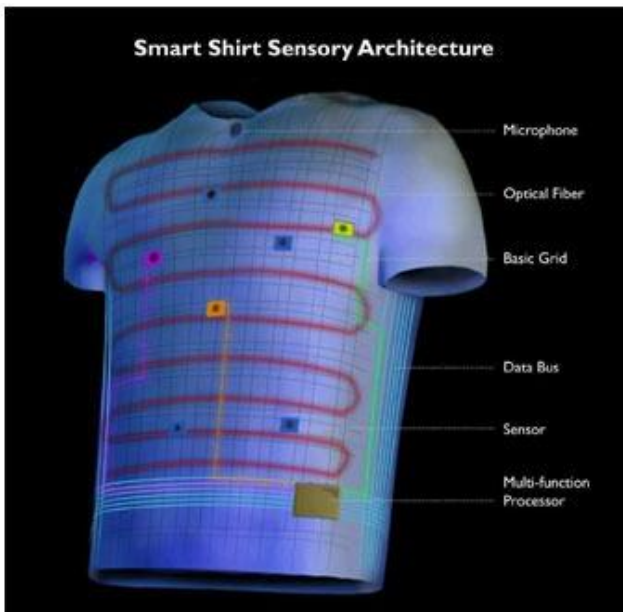


Fig. 5. Smart Shirt Sensory Architecture

**Material of the shirt**

The base fiber is that of standard textiles (e.g. Cotton) and depends on the shirt's application. However a "Weighted Prioritization Matrix" is used often to select the materials to be used. For example, if we wanted to have a smart shirt that could detect bullet penetration, there'd be a certain prioritization of some materials over others. It can be worn as an undershirt or as a simple garment.



Fig. 6. The "Wearable Motherboard," or Smart Shirt, developed by the Georgia Institute of Technology, features a single plastic optical fiber spirally integrated into the fabric with a novel weaving process to eliminate discontinuities at the armholes or seams.

**V. OUR PROPOSAL – SMART SHIRT TO WORK MORE SMARTLY**

In terms of future, we are proposing to add some other sensors in this shirt which will make it work more smartly. In future, the shirt can be made capable of monitoring and analyzing the patients in hospitals, the old people in everyone's home, and, in fact anyone regardless of their age can wear it. The smart shirt mainly consists of wireless sensors and devices for continuous monitoring of the health data and the conductive fabrics to get the body signal as electrodes. Till now smart shirt can measure the electrocardiogram (ECG) which accelerates the signals for continuous and real time health monitoring.

**A. Smart Shirt as Your Personal Doctor**

For the future, we want to give the ideas to make the smart shirt work more smartly by making it a multitasking smart shirt. For this to be practically possible, it will take some insertion processes of enormous amount of healthcare data that could be used to predict diseases and future health conditions of the person wearing the smart shirt. There will be the insertion of the sensors and devices that will be responsible for monitoring the health of person including their body pressure, heart rate and glucose levels. Adding on this, the person wearing the smart shirt can get the names of medicines which he/she can take in a particular disease before going to the doctor. A wearable health monitoring system combined with IOT (Internet of Things) is going to be a conventional healthcare system.



## B. Smart Shirt as Task Manager

The smart shirt can also include the task manager of the person. He/she will no longer have to check their phones for notifications. Once the person feeds their tasks of the day or a week, everything will be managed and notified by the shirt itself to the user.

This feature will help old aged people to feed the reminders to take their medicines as most of the time they forget to take their medicines on time. The young people can also use this feature to save their daily routine including their work, exercises, etc.

By default the smart shirt will set to give reminders of drinking a glass of water in every 45 minutes because drinking water is important for each and every person, no matter of what age.

## C. Smart Shirt as Your GPS Tracker

Smart Shirt can also provide the GPS(Global Positioning System)tracker that gives the location of the person wearing the shirt for the safety purpose.

## D. Smart Shirt as Your Personal AC/Heater

Now we are going to talk about the most helpful and important feature which we want to add in this smart shirt and i.e. Smart Shirt working as your Personal AC/Heater.

Whenever the person will feel hot in summers or cold in winters, he/she can make the shirt cool or warm by just a single tap on the cuff of the shirt. It will use temperature sensors.

*By our proposed work we want to make this smart shirt work more smartly very efficiently.*

## VI. SENSORS AND DEVICE

### A. Kinetic Sensors

Kinetic sensors are the type of sensors that are used in the measurement of applied pressure level, movement of muscles, pressure, number of steps covered by walking/jogging, direction, and location using global positioning system. This sensor can be mainly applicable in the field of military as it can be used for detection of injuries, and stress level.

### B. Physiological sensor

These are the sensors that are used in the measurement of blood-oxygen level, the temperature of body, pressure of blood, composition of urine and sputum.

### C. Blood Pressure Measuring Sensors

Pressure sensors include all sensors, transducers, and elements that produce an electrical signal proportional to pressure or changes in pressures. Pressure sensors are devices that read changes in pressure and relay this data to recorders or switches.

### D. Temperature sensor

A temperature sensor is a device that gathers data concerning the temperature from a source and converts it to a form that can be understood either by an observer or another device. These sensors come in many different forms and are used for a wide variety of purposes, from simple home use to extremely accurate and precise scientific use.

## E. EmbrWave device

There are two types of people in the world: those who always feel a bit too cold, and those who always feel a little warm. The Embr Wave, a unique wearable device, promises to come to the aid of both types of people. Worn on your wrist, the Wave generates small amounts of cooling or warming sensations, which the creators of the wearable calls 'Thermal Waveforms'. These hot and cold waves can be customized depending on whether you need a big hit of warmth or a soothing, prolonged dose of cool.

## F. GPS tracker device

A GPS tracking unit is a navigation device normally carried by a moving vehicle or person or animal that uses the Global Positioning System (GPS) to track the device's movements and determine its location.

## VII. APPLICATIONS OF SMART SHIRT

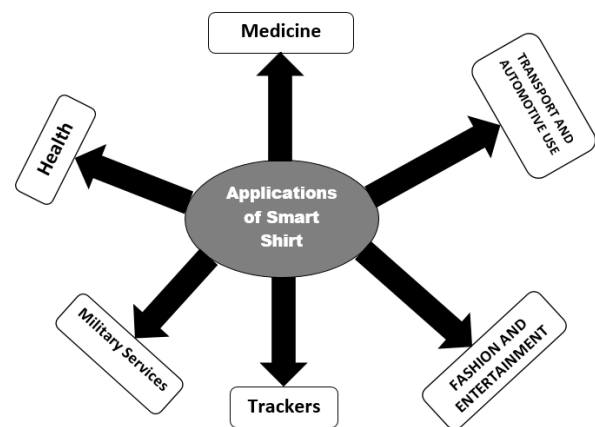


Fig. 7. Applications of smart shirt

### A. Military Applications

Combat deaths usually occur due to the time it takes for an injured soldier to be extracted, assessed, and then treated. The Smartshirt speeds up the assessment process with its sensor technology. The precise penetration is detected and the data is sent off to medical personnel. When the soldier finally reaches Medical Care, surgeons can get right to work and the chances of saving his life are increased. As mentioned before, because the Smartshirt can have a heart rate monitor as well as vital signs, we can know the impact of their injuries in addition to the extent. If you've played any big name shooters, it's like we're moving towards having actual real-time health bars/damage statuses, which can be crucial.

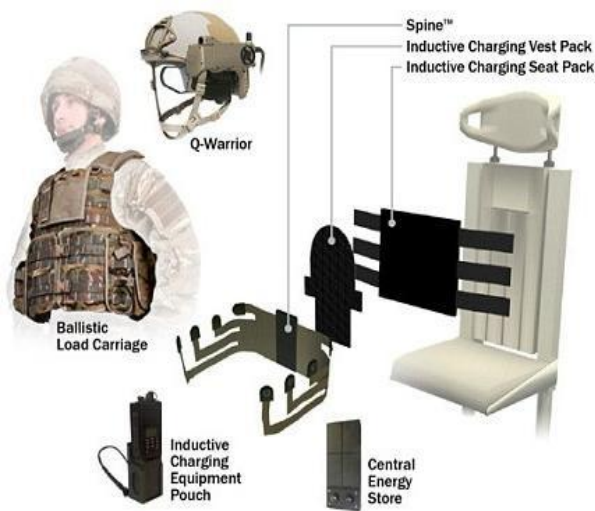


Fig. 8. Internal parts of smart shirt

### B. Medical Purpose

Given the real-time sensor capability and the focus on saving soldiers, not much surprise there is carryover in Medical practices. Primary application is monitoring of patients after high intensive surgery. It allows the patient more mobility and alleviates nurses taking care of them. If the vitals appear off, the system gets alerted and everyone gets brought in. Senior citizens/patients who require constant medical care- Once again, with constant vital sign monitoring, these patients gain far more mobility in their lives than they did locked down in a hospital bed. This also opens up the nurses taking care of them. For example: Diabetic patients, recovering Cancer patients, patients with heart disease.

### C. Other Applications

1. Public Safety-Analyzing the vitals of Police Officers/Firefighters in dangerous scenarios or serving as a Body Cam.
2. Athletics-Can be used to gauge performance for high end athletes or for extreme sports such as cliff diving.
3. It can also be used by Space-Monitor vitals of Astronauts.
4. It can also be used in hospitals for different purpose.
5. Sports person also use smart shirt for avoiding any injury.

The shirt contains the sensors which is used to detect the heart rate, breathing rate and muscle activity of athletics. A micro sensors which is present inside the shirt can identify which of our muscles are working. Sensors analyze the working of the muscle, heart rate and breathing.

## VIII. OBSTACLES FOR GROWTH

Cost and availability: This project has only been created once for DARPA and now lies in the Smithsonian Institution. If it's not being mass produced and constantly refined, it cannot succeed as a true wearable. Furthermore, the current design is rudimentary and crude. Although it is an improvement over the MIT project, it is not integrate aesthetics enough to be seamless enough as a wearable. The only sensors available are the ones military/hospitals use in their day to day necessities; more must be developed for civilian or other usage.

## IX. RESULT AND DISCUSSION

The contents of the journal are peer-reviewed and archival. The journal publishes scholarly articles of archival value as well as tutorial expositions and critical reviews of classical subjects and topics of current interest.

Authors should consider the following points:

- 1) Technical papers submitted for publication must advance the state of knowledge and must cite relevant prior work.
- 2) The length of a submitted paper should be commensurate with the importance, or appropriate to the complexity, of the work. For example, an obvious extension of previously published work might not be appropriate for publication or might be adequately treated in just a few pages.
- 3) Authors must convince both peer reviewers and the editors of the scientific and technical merit of a paper; the standards of proof are higher when extraordinary or unexpected results are reported.
- 4) Because replication is required for scientific progress, papers submitted for publication must provide sufficient information to allow readers to perform similar experiments or calculations and use the reported results. Although not everything need be disclosed, a paper must contain new, useable, and fully described information. For example, a specimen's chemical composition need not be reported if the main purpose of a paper is to introduce a new measurement technique. Authors should expect to be challenged by reviewers if the results are not supported by adequate data and critical details.

## X. CONCLUSION

The growth of technology is never going to stop. Day by day we are getting something new which becomes a big helping hand in our daily lives. From this research we learnt many things. The smart word in the technology itself means that we are making our lives smart. By our research work we want to say that smart shirt will help each and every individual on this planet.

## ACKNOWLEDGMENT

We would like to acknowledge and thanks to Dr. Shaveta Bhatia, Head of Department (HOD) of Faculty of Computer Applications (FCA), ManavRachna International Institute of Research and Studies (MRIIRS), Faridabad for her support and guidance constantly during the preparation of this article.

## REFERENCES

1. Bharti Bisht Study on Wearable Technology with testing of Fitness band(MI Band)
2. Young-Dong Lee, Wan-Young Chung - Sensors and Actuators B: Chemical journal available at: [www.elsevier.com/locate/snb](http://www.elsevier.com/locate/snb)
3. Sungmee Park and Sundaresan Jayaraman Journal on Smart Textiles: Wearable Electronic Systems available at: [www.mrs.org/publications/bulletin](http://www.mrs.org/publications/bulletin)



4. The Georgia Tech Wearable Motherboard™: The Intelligent Garment for the 21st Century, <http://www.smartshirt.gatech.edu> (accessed April 2003).
5. C. Gopalsamy, S. Park, R. Rajamanickam, and S. Jayaraman, J. Virtual Reality 4 (1999) p. 152.
6. DARPA BAA on Electronic Textiles, <http://www.darpa.mil/baa/BAA01-41.htm> (accessed April 2003).
7. SOFTswitch, <http://www.softswitch.co.uk> (accessed April 2003).
8. Features and application of wearable biosensors in medical care: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4766830/>
9. <https://www.digitaltrends.com/cool-tech/embr-wave-review/?amp>
10. <https://interestingengineering.com/smart-clothing-is-the-future-of-the-wearables-industry>
11. <https://textilelearner.blogspot.com/2013/04/applications-of-smart-and-interactive.html>
12. Ray Walters "The rise and fall of the Sony empire", an article at <http://www.extremetech.com/computing/110543the-rise-and-fall-of-the-sony-empire>, retrieved on 5 May 2016
13. Wikipedia, "Google glass", available at [https://en.wikipedia.org/wiki/Google\\_Glass](https://en.wikipedia.org/wiki/Google_Glass) retrieved on 8 May 2016
14. Smita Jhajharia et al, "Wearable Computing and its Application", Journal of Computer Science and Information Technologies, Vol. 5, issue 4, 2014, pp 5700-5704
15. Azhar, Paper presentation "Wearable Computers", available at <http://azharpaperpresentation.blogspot.in/2010/04/wearablecomputers.html>, retrieved on 15 April 2016
16. Jeff Desjardins, "Infographic-The History of Wearable Technology", available at <http://www.visualcapitalist.com/the-history-of-wearabletechnology>, retrieved on 15 April 2016
17. Nate Archer, "Wearable Computers", an article available at <http://www.designboom.com/technology/wearablecomputers>, retrieved on 15 April 2016
18. Lui gough," Review: Mi Band Fitness Monitor and Sleep Tracker ",an article available at <http://goughlui.com/2015/06/02/review-mi-band-fitnessmonitor-and-sleep-tracker>, retrieved on 2 May 2016
19. Laurenti Arnault "The History of Wearable Technology – Past, Present And Future", an article available at <https://wtvox.com/featured-news/history-of-wearabletechnology-2>,retrieved on 2 May 2016
20. Ashley Feinberg "This Wearable Abacus Is Basically the World's Oldest Smart Ring", an article at <http://gizmodo.com/this-wearable-abacus-is-basically-the-worlds-oldest-sm-1545627562>,retrieved on 3 May 2016
21. S. Park, C. Gopalsamy, R. Rajamanickam, and S. Jayaraman, Studies in Health Technology and Informatics, Vol. 62 (IOS Press, Amsterdam, 1999) p. 252.
22. M. Kitazawa, J.F. Kreidl, and R.E. Steele, eds., in Proc. SPIE Plastic Optical Fibers, Vol. 1592 (SPIE—The International Society for Optical Engineering, Bellingham, WA, 1991).

I have a keen interest in learning programming languages and gaining knowledge about the latest technologies and innovations. I am also a blogger and I have a website [www.quickzed.com](http://www.quickzed.com) . Currently I am working on some other project on this website.

The innovations coming out recently fascinates me and increases my interest and the will to work even harder and to be able to come up with a good idea and be able to implement it. I get inspired from people's innovations who are helping the society because one day I would like to be a part of it helping the needy people.



**Juhi Pandey** –I am from UP, and I raised in guru gram. Currently I am pursuing my MCA (Masters in computer) from Manav Rachna international institute of research and studies. I completed my schooling from CBSE board and I have done my BCA (bachelors of computer application) from Maharshi Dayanand University. Telling me about my family background my father is a business man and my mother is a homemaker. We are three siblings .I never made any achievement at state level. But I achieved a certificate in racing competition and in college I take part in NSS for 1 year. My strengths are motivating and confident towards my work and also I am a good learner as well as teacher. My hobbies are cooking food and travelling. Aim of my life is to become an independent and work in my dream company.



**Nikita Yadav** -I was born and raised in Delhi. I have completed my schooling from CBSE board, then I did my BCA (Bachelor in computer application) from Maharshi Dayanand University and now I am pursuing my MCA (Masters in computer application) from Manav Rachna international institute of research and studies .We are four in my family. My father runs their own business and my mother is a housewife. I have one sibling and my elder brother is studying. strength are hard work and dedicated towards my work .about my achievements in my schooling I got certified in drawing competition and in college I take part in NSS for one year. My hobbies are making crafts painting and doing some adventurous activity. Goal of my life is to work in MNC and give my best.

### AUTHORS PROFILE



**Prof. (Dr.) Shaveta Bhatia** has been awarded her Ph.D degree in Computer Applications. She has completed her Master in Computer Applications (MCA) from Kurukshetra University. She is having 17 years of academic and research experience. She is a member of various professional bodies like ACM, IAENG and CSI.

She has participated in various National and International Conferences and actively involved in various projects. There are more than 40 publications to her credit in reputed National and International Journals and Conferences. She is also member of Editorial board of various highly index journals. Her specialized domains include Mobile Computing, Web Applications, Data Mining .



**Sonali Chopra** -I am a student of Manav Rachna International Institute of Research and Studies (MRIIRS), Faridabad, Haryana. I am currently pursuing MCA (Masters in Computer Applications). I did my Bachelor's in Computer Application from Jamia Hamdard University, New Delhi. I am a web application

developer and an android application developer. I was an intern in Web Development for one month (from 18<sup>th</sup> June 2017 to 18<sup>th</sup> July 2017) at FRANS GLOBAL INFOTECH (P) LTD. I was also an intern in Android App Development for one month (from 15<sup>th</sup> June 2017 to 15<sup>th</sup> July 2017) at FRANS GLOBAL INFOTECH (P) LTD. I have designed a few websites as a project in BCA and I have made a project on basketball court counter using android studio. In my MCA, I have developed a web application named RentUrCar using PHP as backend and SQL database.

