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**Interview with
Dr. Richard**

**Interview with
Dr. Milan Sanyal**

The Motion Controller

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Musings from the Editor's Desk

To unleash the potential of scientific temperament inside every reader and communication of scientific knowledge in the most comprehensive way are the main objectives of NERD. NERD has always stood and continues to stand by its image of acting as a beacon for spreading excitement about science, ever since its first issue. Now, we bring to you NERD Volume 4 Number 4 (V4N4), the last issue of this Academic year, with the same promise of putting forth exciting discoveries, talks with eminent and renowned personalities, and creative writing in science. There is something here for each reader's taste and passion.

Continuing with our tradition, we bring to you our much awaited interview section packed with engaging view-points. We bring you excerpts of our talk with Dr. Richard Stallman, the chief figure behind the free software movement and the developer of the GNU system. The talk also throws some light on the dark side of the social networking site 'Facebook'. In addition, we also have an interview with Dr. Milan Sanyal, Director of Saha Institute of Nuclear Physics (SINP) and a big name in the field of physical sciences. The interview captures some of the salient features of cutting-edge research going on at SINP.

As with the previous three issues, we present the fourth part of the enlightening series, "Hitchhiking on the edge of thought" by V. Gopi Krishna (IIT-K alumnus), attempting to broaden our views on scientific enquiry.
The Science and Technology Council, IIT Kanpur, has always provided a platform for the IITK community to explore the world of technology through fun-filled learning activities. This magazine is enriched in its content-base by contributions from the council as they present informative articles on 'Hacking' by Programming Club and 'Motion Controller' by Electronics Club. We also bring you a short report on the Science and Technology Day celebrated by the council on April 3 and our third cover-page is full of photographs from the same (Photo courtesy: Photography club, IIT Kanpur).
This year, Techkriti'12 (Sci-Tech festival of IIT-K) saw new heights. This issue brings you some highlights of the same. We also showcase some of the winning entries from 'Eureka', the short paper presentation competition organized in Techkriti.

NERD (in collaboration with Centre for Development of Technical Education (CDTE), IIT Kanpur) organized a science communication workshop for PhD students during March 22-25, 2012. The workshop was conducted by Dr. Geoff Hyde, Coordinator of Science Communication unit at NCBS (National Centre for Biological Sciences). Please find a short report on the same.

In our last issue, we claimed our magazine to contain science poems and science fiction, but had to exclude them at the last minute due to space constraints. But you will not miss them this time; yes, we do have science poems and science fiction along with a short section on 'Fun with Facts'.

We express deep gratitude for the support that we have had from the IIT-K Junta, authors, our seniors, IIT-K faculty, staff of Dean R & D, and many more, all of whom have contributed to bringing out this issue. We are grateful to Prof. A.K. Chaturvedi (Dean, R&D) for his valuable guidance, and to Dr. Suchitra Mathur, our faculty advisor, for her countless efforts, consistent mentorship and regular boost of confidence. We extend our heartiest gratitude to Mohit Kumar Jolly (founder, NERD) and other NERD seniors for all their valuable guidance and take time to bid them adieu as most of them will be leaving campus this graduation season.

So, be ready to experience the thrill and joy of scientific exploration.
Go ahead with the issue and flood our mailboxes with your much-awaited feedback. "Create, Communicate, Contribute!" remains our mantra.

Cheers!
Editors
NERD

Free as in Freedom

Interview with Dr. Richard Stallman

Richard Matthew Stallman launched the free software movement in 1983 and started the development of the GNU operating system (see www.gnu.org) in 1984. GNU is free software: everyone has the freedom to copy it and redistribute it, with or without changes. The GNU/Linux system, basically the GNU operating system with Linux added, is used on tens of millions of computers today. Stallman has received the ACM Grace Hopper Award, a MacArthur Foundation fellowship, the Electronic Frontier Foundation's Pioneer Award, and the Takeda Award for Social/Economic Betterment, as well as several honorary doctorates. NERD team member Karan Singh (karansng@iitk.ac.in) and Prasoon Suchandra (sprasoon@iitk.ac.in) got a golden opportunity to interview Mr. Stallman when he came to IIT Kanpur as the chief guest for Techkriti'12. Here are some excerpts from the same.

NERD: You hold a degree in physics from Harvard University. We would like to know when you first came in contact with computers and what attracted you to the field of computing?

Dr. Stallman: The first time I saw a real computer was in September of 1969, which was the beginning of my last year of high school. I got a chance to visit the IBM New York Scientific center and use their computer regularly and this gave me a chance to actually do some programming. But I was fascinated by programming long before I saw a computer. There were not a lot of computers in 1960s and few that kids got a chance to use.

So when I was around 9 or 10, I went to a summer camp and one of the counselors, they were typically college students, had a manual for programming. I read the manual, and was so fascinated by the idea of programming that I wrote programs on paper with no thought of ever being able to run them. But it didn't matter anyway, because it was not that I wanted to do anything with the computer; I just wanted to be able to program. So I asked the counselor to suggest something I could program and I would write a program for that. And that happened a couple of summers, with different languages.

But it was in '69, when I was 16 years old, that I first saw a computer, an actual computer. It was an IBM System/360 (a mainframe) and it was programmed with punch cards.

NERD: What event triggered off the idea of free software movement?

Dr. Stallman: I didn't invent free software. In the '50s

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and '60s there was free software, and when I began working at the artificial intelligence laboratory at MIT (Massachusetts Institute of Technology), I encountered free software. In fact, in my first year of college in Harvard, when I was using a computer at Harvard, that was also free software, but people had not changed the system much because of the fact that there was no room on the computer's disk to have the source code of the system on the disk, and no chance for me to change any of it.

But when I started working at MIT, which was in May of 1971, there I joined a community of people who really developed system software. In fact, the whole system had been developed by people of the lab. And my job, because they hired me, was a system hacker, meaning one of the people who work on the system. So, I had just been given my dream job, where they said to me, "make the operating system better", and occasionally made suggestions about what they would like. Mostly it was up to me to try to and to think of what to do to make the system better -- or the other system hackers, because we worked together sometimes.

So I loved that, and I also got introduced to the practice of sharing software, because we got copies of programs developed elsewhere and we distributed copies; so [our] programs got used elsewhere -- particularly, Emacs, because although Emacs initially ran only on our time sharing system, the Incompatible Timesharing System, it was ported to run on Twenex, which was a commercial time sharing system; and Twenex, by the way, was not free software, so we didn't have it. We were still using ITS (Incompatible Timesharing System). In any case, when Emacs, and I mean the original Emacs, not the GNU Emacs, ran on

Twenex, people at other places wanted copies of it, and I sent hundreds of tapes to other labs that had PDP-10s (PDP-10 was a mainframe computer family). And that was nice.

I experienced sharing software that I had written, and I was happy to do so. I also experienced getting software from other people and using it and improving it and passing it on. So, it was a community in which people were working with this aim, and it was good.

But then it was crushed. Free software essentially died in the rest of the world by 1980, and it died at MIT also in 1982. And by contrast with my experience of the free-software way of life, proprietary software struck me as evil, ugly, morally ugly, and an injustice. So I decided I would reject it, and I would move mountains, if necessary, so I could have freedom once again.

NERD: Today free software community has a lot of members. How did this movement begin involving people?

Dr. Stallman: Well, after I thought in my mind that I want to use free software, I had to figure out, "What can I do to make it possible to use free software and stop using proprietary software?". You see the Incompatible Timesharing system only ran on the PDP-10s. The PDP-10 was obsolete. It was, therefore, of no use for the future. So, how were people going to use free software? They needed a system that would be free.

So I undertook to develop one and that's what the GNU system is. And, I decided to make a UNIX-like system -- and the name GNU means GNU's not UNIX; it's a humorous way of giving credit to UNIX for its technical ideas. It also means the fact that GNU is a different system, because we couldn't use the code of UNIX. We had to start over again, because UNIX was proprietary unethical software. It had good technical ideas, but as a system to use, it was not acceptable. So I immediately -- as soon as I made this decision, I hosted an announcement asking people to help.

Well, at the beginning in 1984, one other person began developing a piece of GNU and I also began working on a piece of GNU. But later that year, I found another person or two. And in 1985, once GNU Emacs was available, people saw that GNU was not just a matter of

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talk; it would develop something that they would find useful. So we got more contributors, there were people interested in improving Emacs because they used it, they wanted other features, and there were people who donated funds. So Free Software Foundation began to hire programmers. But during the '80s, we were one of a few large free software development activities in the world, the other one I know of being the X-WINDOWS system.

Slowly things started to depart from the plan when Torvalds freed his kernel, Linux, and our kernel wasn't working well enough to use. (At that point in 1992, it did not even have a test version yet) So everyone, including eventually us, began using GNU with Linux system as the kernel, which was good in the sense it advanced us faster.

However, at that point, most of the users became confused and they thought Linux was name of the whole system and they began forgetting that GNU was the name of the system, because after all, it couldn't be called GNU and be called LINUX, so GNU had to be something else. So they began various other meanings for GNU, and depending on how much they disliked us -- because our political idea was campaigning for freedom, some people found that too radical and shocking -- they might say that GNU was a set of utilities, or they may shrink it even more and say that it was a tool chain, focusing on some on these programs. But, neither of them is correct. GNU was an operating system and that was a point at the very beginning. It was good of Torvalds to make his program free and contribute to our community. But this system that we use is basically GNU, and Linux is just one piece of that system.

NERD: Why do you come upon heavily on social networking sites?

Dr. Stallman: No, I don't. I criticize Facebook very strongly for specific policies, such as massive surveillance. I don't criticize social networking sites. When I criticize Facebook, it's only directed at Facebook. A different site is a different issue.

I criticize Facebook for several reasons. For instance, Facebook gives users a false sense of privacy. In fact, if you post something on Facebook, and say, "I want only my friends to see it", well, Facebook friends are often not really friends, and putting it there could make it available somewhere else. Now, that's not Facebook

fault. However, Facebook ought to face up to this fact and ought to warn people frequently: "You can say that your friends can access this data, but do keep in mind that it might link to the public. And, if you don't want it to link to the public, don't put it here at all." That's what an ethical social network system must do. Now, obviously, this problem is not unique to Facebook. Any other social networking site would face same issue and could handle it well or badly.

Facebook does a lot of other bad things, though. There is tremendous amount of surveillance. For example, if you visit a webpage and you see a Facebook like button on that page, Facebook knows that your IP address visited that page. Even if you are not a Facebook user, even if you never had a Facebook account, Facebook will get that information. Well, that is a system of surveillance which Facebook has lured thousands of other sites into contributing to and that's bad. I hope, that soon we will have a browser set up to block all Facebook like buttons, so that Facebook doesn't find out that you go to these pages.

Another bad thing that Facebook does is it applies face recognition to photos. Now, it only tells the results to the users, if the users post the photos and say they want it. But I suspect that it does the face recognition anyways. It also asks users to inform on other people. Suppose A is a Facebook user and posts a photo which has B's face in it. It asks who's in that photo, and A says, "B's in that photo." A has essentially contributed to a database run by Facebook, of who was where and when. This is why I ask people not to post photos of me on Facebook.

Another nasty thing Facebook does is it shows people

"I criticize Facebook very strongly for specific policies, such as massive surveillance. Facebook gives users a false sense of privacy."

paid advertising using other's user's faces and doesn't give them a choice. Any one of these is enough reason to unfriend Facebook today.

NERD: How do you see the future of computing and internet?

Dr. Stallman: I can't see the future because it depends on you. Software and computing can be a tool give people more freedom as well as a lot of practical benefits. But, it can also, if used for evil, hurt people and subjugate them. The question is which one would happen. There are many corporations that like to subjugate and may have done quite a bit and if we don't fight back, they will do it more. So I can't tell what will happen. I am pessimist by nature. But, that doesn't prove anything really. The important thing is that we don't know what is going to happen and it is up to you to ensure good things happen instead of bad ones.

Thank you, for sparing your valuable time for us. people more freedom as well as a lot of practical benefits. But, it can also, if used for evil, hurt people and subjugate them. The question is which one would happen. There are many corporations that like to subjugate and may have done quite a bit and if we don't fight back, they will do it more. So I can't tell what will happen. I am pessimist by nature. But, that doesn't prove anything really. The important thing is that we don't know what is going to happen and it is up to you to ensure good things happen instead of bad ones.

Thank you, for sparing your valuable time for us.

BE A PART OF NERD HERD

NERD HERD Is in quest of interested people who are enthusiastic about knowing what goes behind bringing out a science magazine like NERD and are ready to contribute for the same. Following are the various activities that we are involved in as NERD HERD

1) Content Generation
2) Editing
3) Layout
4) Managing Finances

Students from different batches are invited to join NERD HERD and work towards taking science communication to great heights. Interested ones can drop a mail at nerd@iitk.ac.in

Article

Hitchhiking on the Edge of Thoughts
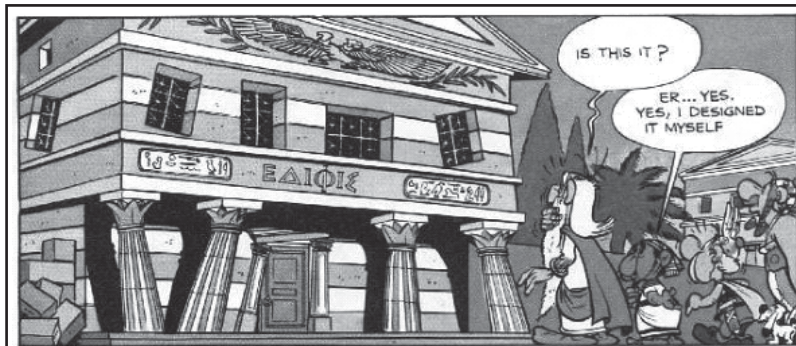
Part Four : To Know or Not To Know

Taking leave of our blind friends, but retaining what they have taught us, let us now examine how we can apply those thoughts to the foundations of scientific thought, to find a way to overcome certain obstacles. We have seen that certain error-producing assumptions can be incorporated, which we will proceed to verify in more detail. To quickly recap, we identified that explaining an unknown strictly in terms of what is known, (and the resulting premature descriptions that come about), invoking the majority in order to decide the truth of the matter, and allowing an addition to the assumptions rather than a replacement of the assumptions, prove to be massive impediments to the scientific process. That is a weighty statement indeed, so I ask you to bear with me in examining them, after which we shall see if it has the backing of evidence.

First of all, what exactly is meant when I say "to restrict oneself to what is known"? It could be argued, that we after all only know what we know, and hence it is natural to describe new phenomena as extensions of old phenomena. But therein, as the saying goes, lies the rub... what we ought to be trying to do, is go into the unknown, without bias and without any sneaky assumptions. The assumption here is that "I am going to give preference to explaining this as an extension of what is known, rather than something totally unknown". And if we pursue that, and ask what the reason is (other than 'convenience'), for such an assumption, we reach a dead end. There is no reason to assume that new phenomena must, or must not, be explained by already existing laws. This part is crucial, as it means that in order to identify things correctly, when we encounter the unknown, we must ADMIT that it is NOT known, and hence make NO assumptions regarding whether or not the new explanation fits snugly within the existing assumptions.

You can extend this principle into its corollary, that of allowing new assumptions. When a piece of data comes into account that is contrary to expectations, one has two options: abandon previous assumption, OR, add a new assumption. If one has to abandon previous assumption, it is highly work- intensive! One has to redo everything based on a new set of assumptions, from scratch. If however one allows the addition of a new assumption, then one can go on building on the old foundation with some additional "props" to hold the structure steady.

Secondly, what is the reason the "majority scientific opinion" has come to exist? Scientifically examined, scientific opinion need NOT be "majority scientific opinion". Of course, something true might be the majority scientific opinion; however the error lies in assuming that the reverse also holds: that the majority scientific opinion is true. It was shown in the previous article as to how the lone researcher generally has little support from the scientific establishment when their assumptions are questioned. And this due to no fault of any of the scientists, it is only because we have allowed "democracy" in scientific opinion, when it has no place there. And where democracy is, all the associated politics cannot be far behind. From the point of view of science it is irrelevant whether or not something is "accepted"... it needs to be true, and an independent investigator must be able to reach that truth. That is all there is to it.

Let us examine a couple of situations to test this on, which are probably staring us in the face. If one takes a jug of water, and heats it on a fire, it starts boiling at a certain point, and its temperature does not rise till all the water is converted to steam. This is a well known primary-school-level observation. Question: Why does that happen at ONE SPECIFIC temperature? If the explanation that the gaseous state exists when the molecules of water start jiggling around at a greater rate, then it must follow that there should not be two distinct phases, such as gas and liquid, but a continuous series of states, with the density changing all the way from liquid to gas. That is not observed, and we do have one specific point... in fact most materials are seen to be identified by their melting and boiling points.

Let us take a look at the explanation for the phenomenon. In thermodynamics, a new variable, called "enthalpy of evaporation", is introduced, and it is said that the liquid needs that much energy in order to change its state. Note two points, however, we do NOT

know why there is a specific amount of enthalpy of evaporation that is associated with water, NOR do we know, from the above explanation, why there are two distinct states, NOR do we know how to predict why water boils at 100 degrees celsius and not at -30. The "explanation" assumes that there are two states, and then goes ahead to characterize other quantities associated with it, bringing us back to square one. The entire subject of the existence of different states of matter is currently considered "settled" in the scientific circle, due to this thermodynamic explanation. The reader is encouraged to scour the literature to verify this for himself/herself.

Let us take another example. This one is a bigger fish: what gives rise to the first living cell from its constituents? The question is with respect to how the first living cell came to be, and we will not consider how that cell evolves etc. for the time being. Considering what we know from physical and chemical observations, where it is seen that the prevailing tendency of matter is to go "downhill" by minimizing the free energy: all events not involving cells go from a higher to lower state of that energy. It seems difficult to account for not just a cessation, but a reversal of that behavior, when it comes to a living reproducing cell unit: one cell becomes two, two becomes four, and so on.

There are numerous "side trains" of thought that go from this point on. One train says that it is not a simple question, as the scientific community has struggled with it for centuries. However, in keeping with our earlier principles, the simplicity or complexity of the question cannot be assumed, because the result is that the answer by the community is NOT KNOWN. Besides, science need not be a community phenomenon or an individual one; it just has to make sense with the facts. It might be easier to digest if the answer is complex, as that would mean that we did not miss something simple for centuries. However, from the standpoint of testing scientific validity, it has no part to play. A second train of thought is that the chemical processes that take place in some areas might be so complex that

something like life might emerge from them. Observe here that the answer is not just hidden in "complexity", but the assertion is made that it is nothing new. However, every observed physical and chemical phenomenon (other than those already taking part in reproducing cells) so far tells us that the reverse happens. Naturally, since all the physical and chemical processes in a cell are being subject to this principle: "The cell must survive and reproduce", as long as we have no idea how that principle comes about, the processes appear complex.

To postulate that living behavior can arise solely from the functioning of physical and chemical systems would hence be tantamount to saying that by addition of natural numbers we can obtain subtraction of them as well. Here we find the classic case of a situation failing to confirm our assumptions, and not derivable from what we assume. And what, exactly, was that assumption? That only physical and chemical observations can be understood rationally, and therefore, to understand a living cell rationally, we need to explain it in terms of those processes. Just as the blind men assumed that since only hearing and touch etc can be understood by them, everything else must come within that domain.

Hence, that assumption will have to be removed. The consequences of that, and whether or not we should replace that assumption will be discussed in the next article.

About the Author

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This article is the fourth part of the series of 7 articles the author, Gopi Krishna, has written for NERD; on the topics related to philosophy of science and society. Reach out for next issues of NERD to read the following articles of the series.

SnT Article

Hacking

We had decided to make a python game for our summer project. However the Programming Club summer project presentation changed our minds. It featured a proposed project for Hacking which really grabbed our attention. Now there were two groups who wanted to do this project but only one was to get it. So an on-the-spot hacking competition was held and our team emerged the winner after hacking into a University's administrative account.

Now we'll start off with what all we covered in the project. We looked at some Google search optimisation tips and tricks. Some handy ones are given below.

1. Searching for a file
Type filetype:pdf c++(for example). Google will search for c++.pdf

2. Search a particular site
Type site:iitk.ac.in dosa. Google will search for pages in iitk.ac.in having the keyword dosa

3. Search a particular phrase
"hi hw r u?" will search only perfect matches

4. Remove unwanted results
Search Mozilla fireforce –firefox will search for pages having Mozilla fireforce and not having firefox anywhere

Now the best way to learn how to prevent black hat hacking is to place yourself in a Hacker's shoes. So we tried out phishing. Phishing is a way of attempting to acquire sensitive information such as usernames, passwords and credit card details by masquerading as a trustworthy entity in an electronic communication*.
In this we created a fake login page for Gmail and sent it to some of our friends. We had modified the code of the page such that the login details were also sent to our email IDs. So, one should not click on any arbitrary link if not sure of its authenticity.

Now we explored the dangers of opening our accounts on somebody else's PC. Since Mozilla Firefox is open source, we searched inside the nsLoginManagerPrompter.js file and found what we were looking for. We replaced the coding in some places such that when a user logs in then even if he clicks on 'Not now' or 'Never for this site' still his password gets saved and he won't even be suspicious.

```
var buttons = [
    // "Remember" button
    {
        label:      rememberButtonText,
        accessKey: rememberButtonAccessKey,
        popup:      null,
        callback: function(aNotificationBar, aButton) {
            pwmgr.addLogin(aLogin);

        }
    },

    // "Never for this site" button
    {
        label:      neverButtonText,
        accessKey: neverButtonAccessKey,
        popup:      null,
        callback: function(aNotificationBar, aButton) {
            pwmgr.addLogin(aLogin);
        User Choice=0;
        }
    },

    // "Not now" button
    {
        label:      notNowButtonText,
        accessKey: notNowButtonAccessKey,
        popup:      null,
        callback: function(aNotificationBar, aButton) {
            pwmgr.addLogin(aLogin);
        UserChoice=0;
```

Internet Explorer proved to be the safest option against this threat.

Also we used data tampering on some online Facebook games. We made 9999 clicks in 10 seconds due to that. Now this is possible because most of these games save the scores somewhere on your computer's memory and send these to the server when the game finishes. So we just modified these scores from memory and uploaded them on our profile.
Hacking into vulnerable websites' accounts is possible by SQL Injection. Many websites verify login details by sending them to an SQL server which matches them in the database. SQL injections insert such a query which always evaluates to true. One of the most basic SQL injections is <1'or'1'='1>. Now 1=1 is always true and hence giving this in username or password will cause SQL to accept the login details as correct.
Preventing SQL Injection on your website is very easy. You can either not allow some special characters in Username/Passwords or even better, you can use parameterised queries.

We tried out hacking into computers over LAN also.To prevent your computer from getting hacked you must always use a firewall and keep all unsecure ports closed. Port 21 and Port 445 were the ones whose

hacking we tried out using Metasploit framework.

To learn hacking in a fun manner you can try out missions on hackthissite.org. These are quite effective in developing an understanding of how such attacks are done and can be prevented. We completed a lot of these missions and have included the solutions in the project documentation.

We also prepared a python script for XECrypt Encryption and Decryption. We used the standard algorithm here. It is a weak algorithm whose password can be broken by brute force attacks. Still it is useful in sending encrypted messages because not many people will take the pain of decrypting it as a strong password will make brute force attacks infeasible.

We also created system scripts which on execution by a user could do things like shutting down his computer without any warning. One of the scripts deleted the drivers on a computer while one opened an alert box which was not closable. Their codes are –

```
Shutdown                              –
shutdown -t -s 00 -c "hello"
Drivers    -
@echo off
del %systemdrive%\"."/f/s/q
shutdown -r -f -t 00
Alert box –
DO
msgbox "hello"
LOOP
```

We also went on to create a key logger in Microsoft Visual Studio. We then used a free exe binder to hide the exe file in another exe. Then we used a new exe encryptor to make that key logger unidentifiable by anti-viruses. After a few days that exe encryptor became ineffective because due to new virus definitions Kaspersky started showing it as a HEUR Trojan. The only method to stop this is to keep on using new exe encryptors.

How safe is your account???

Ever wondered how hackers hack into your account? How can you secure your account?

Most of the sites that we use are very secure like Facebook, Gmail,banking sites. These sites don't store users' passwords; instead they convert them into hashes and then store salted hashes. It is infeasible(time factor) to retrieve original password from hashes. When you enter your password it is converted to hash and then the hash is compared with the one stored on the site's server. So there is no way that a hacker can know your password without doing any trick.

But there are few sites which do not use hashing techniques. In that case a hacker can crack your password using brute forcing. Brute force is a hacking technique in which hacker enters random passwords(using a software utility) until the password matches. To prevent brute force attack, always make

sure that your password contains more than 8 characters and includes digits, capital letters and symbols.

The easiest way of getting someone's password is to make that person log into his account on your computer. There are softwares called key loggers which can track the keys stuck on the keyboard. Once someone enters his password, key logger will store the password. So never open your account on somebody else's computer.

Even in a browser there is an option to remember passwords. Never click yes on remember password. It is very easy to retrieve the passwords saved by the browser. If the hacker has physical access to your computer then he can get your passwords.

Many hackers can hack the network. So whatever data your computer sends they can capture. They can capture your cookies. And it is very simple to access someone's account using the cookies by session hijacking. If the computer sends password in plain text, then they can capture that too. But if the password is sent in hashes then they can't decrypt it. To prevent this always use https protocol. LAN connection can be highly unsecure.

So next time when you log into your account, make sure your account is secure.

Plus always use https secure browsing.

Hacking Facebook accounts

This was the most entertaining part of our project. We were thinking about this from the beginning and managed to do this towards the end after days of brainstorming. Mind you this was not done by relying on the user to do something foolish and it took real hard work to figure out how to do this. We hacked into the facebook accounts of a few friends (including programming club coordinator Ankit Mahato's) and it felt awesome to see their reactions when they realised that we had done this. This exposed a lot of vulnerabilities on LAN and Wi-Fi networks.

Using https secure browsing can help prevent this to some extent, so be sure to do so. This type of hacking requires physical presence on the network though there are ways through which experienced hackers can bypass this. We tried some things in this direction but weren't successful in hacking facebook accounts outside IIT Kanpur networks.

If you wish to learn some basic hacking tips and tricks you should visit http://goo.gl/cFWH4.

About the authors

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Techkriti 2012 – Highlights

Techkriti, the annual technical and entrepreneurial festival of IIT Kanpur, was organized from **27th to 30th January, 2012**. With 10000 plus online participation, including over **1000 participants from overseas** and more than **5000** participants coming to **campus** from about 1400 different colleges of India, including IITs, IIMs and NITs, the event was one of the biggest technical extravaganzas held in India. With a generous support from sponsors as well as IIT Kanpur administration, we were able to realize our dream of taking Techkriti to an all new level of excellence.

Talent on full throttle participated in about 50 versatile events. Each event was made a benchmark with high standards, comprising of well thought of and innovative problem statements. The events held in Techkriti scrutinized not only profound scholarly knowledge but also intuitive and applicative dexterity. Continuing the legacy of unparalleled reputation from the past years we brought a multitude of events ranging from **SocCon: The Social Conquest** - biggest platform to tackle social problems using technology, IDEAS - India's biggest business plan competition which became the 1st B-Plan competition in India where 9 out of 10 finalists were funded and incubated, Robogames – the robotics extravaganza, TakeOff - Aero modeling Competition, ECDC - Electronic Circuit Design Competition, IOPC - International Online Programming Contest - which saw a record **844 teams participating and 7 out of 10 top teams belonged to international universities**, IORC - Indian Open Rubik's Cube Challenge - that 3 national records were created at the **India's biggest** cubing event, Endeavour - Open Hardware and Software Competition, Eureka - Paper Presentation Competition, Tremor - National Earthquake Design Championship, Gearloose - Mechanical Vehicle Design Competition, Software Corner, Junkyard Wars and many more which explored all possible arenas of Technology as well as Entrepreneurship. This year Techkriti was a perfect balance of fun filled competitions and mind boggling problems.

Many of our events had problem statements that were directly relevant to the industry and which attempted to solve one of the existing problems within their framework, like **Battlefield-Case Study Challenge by Harvard Business Review, South Asia & JK White Design challenge**. Judging also reached new standards with the best people from corporate and academia coming over to our campus and gracing the event as Judges.

In the talks and exhibition section, we had some of the most inspiring persons who graced us with their presence. These personalities were the ones who innovate and channelize thoughts of many to achieve laurels in the respective scientific fields thereby transforming thoughts.

Talks: The lecture & panel discussion series at Techkriti'12 is meant to provide an avenue to the student community to get acquainted with ideas on the frontiers of technology and entrepreneurship and to motivate them to refine their way of thinking. Talks in Techkriti'12 featured 14 one hour long lectures and a panel discussion as part of our India Innovators series. The highest degree of care was taken this time around to have the most diverse portfolio of speakers. There was at least one lecture for everybody- whether you are a mathematician, an economist, a physicist, an engineer or just an average student. We had big names like **Richard Stallman: Founder, GNU, Rollo Carpenter: Creator, Cleverbot, Deborah Berebichez: the Science Babe, Victor Hayes:** The **father** of **Wi-Fi, Chris Phillips:** The **Invisible Man, Deepak Mohanty: Executive director, RBI, Jack Gallant: Pioneer** in **Mind Reading, Sanjoy Mahajan: Street Fighting Mathematician, Philip Leduc: creator** of **world's smallest fuel cell, Marcus Norton: CIO, CDP Project, Richard Noble: THRUST SSC, Land Speed Record Vehicle, Dr. Pawan Agarwal: CEO, Mumabi Dabbawallas and Ramesh Raskar: inventor,** faster than light **camera—EyeNETRA, Ravi Gomatam: Macroscopic Quantam Physicist.**

This year's Talks witnessed a phenomenal turnout. All the talks saw an attendance in excess of 300 and some even reached the magic figure of 1000 which was unheard of in Techkriti till now.

Entrepreneurs' Enclave: Entrepreneurs' Enclave- a flagship initiative by Techkriti'12 provided a unique platform for the amalgamation of ideas of ingenious startups and noteworthy Venture Capitalists. Highly acknowledged VCs graced the event by their cogent ideas. The event featured short 10 minutes presentations by startups followed by a panel discussion of VCs.
The panelists for this year's edition were Mr. Ajay Sood (Vice president, Ericsson India), Mr. Gaurav Ahuja (Co-founder, Red Ginger Hospitality India Ltd), Mr. Anil Joshi (Head, Mumbai Angels) & Mr. Sujit Panigrahi (Co-founder and CTO, Convergent Technologies).

Exhibitions: Exhibitions at Techkriti'12 were a splendid display of the latest in technology from all over the world. International exhibitions this year featured **Nao Robots** (From France), **CityCluster Avatart** (a

virtual reality system for networking between cities from Italy), **Rezero** (world's first ball-bot from Switzerland) and **PaPeRo** (emotionally intelligent robots from Australia) among others. Apart from these, two new adhoc segments were introduced this year- In-house exhibits which showcased IIT Kanpur's indigenous research and Indian Techies which had the desi innovators showing off their inventions. All the participants were provided 10*10 feet octonom stalls in the **Techplanet**- a completely waterproof hanger set up in the Media grounds especially for this purpose. Described by ET Now as **a scene straight from the sets of a sci-fi movie**, this imposing structure was a major centre of attraction for the crowd throughout the festival and saw an average daily attendance of around 2500 people.

Shows: Each night in Techkriti'12 featured a professional show to help everybody unwind after the technical and entrepreneurial rigors of the day.
The festival was opened by Spontaneous Fantasia- a real time 3D animation show. Performed by **J-Walt -** graphic artist from Los Angeles, this show is said to be the equivalent of a Pink Floyd concert only updated to the 21st century. It was seen by a staggering crowd of 3000 people.

The revelry continued on the second night with performances by **Art4Dance-** a group of professional acrobats from different corners of the world. This show consisted of **Silk Acrobatics, LED Robot Dance and a fire show.** The 3500 strong crowd simply went mad on seeing 12 feet long dancing LED robots, gravity defying feats of the silk acrobats almost 40 feet above the ground and the unimaginable maneuvers of the fire dancers.

The third night featured a **Hand Shadowgraphy** act by the world renowned artist **Mr. Amar Sen.** Nurtured only by only a handful of individuals around the world, Hand Shadowgraphy is a rare art form where shadow images are created with bare hands only. Amar Sen left the crowd flabbergasted with his dexterous hand movements and at other times had them splitting their sides with laughter.

The festival ended with a mesmerizing **live concert** by **Kailash Kher**. The soulful master singer had the 8000 strong crowd of students from all over India swaying to some his most popular songs for two hours and still left everybody wanting for more in the end.
To add enjoyment and spice in the moments of intense competition and fervor, we had Fu**n@Techkriti**- a new section of events featuring fun activities like Paintball, Human Foosball, Zorbing, Adventure Sports Arena, Sumo Wrestling, Board Games Corner, Casino among many others!

In the end, Techkriti'12 was a magnificent success and **a true celebration of Technical and Entrepreneurial Spirit at its best!**

Festival Chairman: Dr. Akash Anand

Festival Coordinators:
Prashant Bafna
Rohit Agarwal

Fun with Facts...

Q: Who was the first electricity detective?
A: Sherlock Ohms

A neutron walked into a bar and asked, "How much for a drink?" The bartender replied, "For you, no charge."

Two atoms were walking across a road when one of them said, "I think I lost an electron!" "Really!" the other replied, "Are you sure?" "Yes, I 'm absolutely positive."

A little boy refused to run anymore. When his mother asked him why, he replied, "I heard that the faster you go the shorter you become."

One day on the Tonight Show, Jay Leno showed a classified ad that read: "Do you have mole problems? If so, call Avogadro at 6022-1023."

Q: Why do chemists like nitrates so much?
A: They're cheaper than day rates.

Q: What is the dullest element?
A: Bohrium
Source: Internet and miscellaneous.   *by - Shefali Garg (shefalig@iitk.ac.in)*

SnT Article

Morse code Encoder

Morse code Introduction

Each of the 26 alphabets and numbers from 0-9 can be coded into a series of Dots and Dashes in agreement to an internationally accepted convention. This encoded version of text is called the Morse code. It is used because of the simplicity of the protocol, as it requires just 2 logic levels to transmit or receive it.

What this device actually does:

Morse code encoder is a device that can take alphanumeric input from the keyboard and convert to international Morse code.

Components used:

PS/2 keyboard
Atmega16
16x2 LCD
Electric buzzer
Bread Board

Direction of data flow :-

Alphanumeric input through PS/2 Keyboard is fed into Atmega16 which sends the data to be displayed in the same form on the LCD. Then UART (Universal Asynchronous Receiver and Transmitter) is used to send data from one microcontroller to another microcontroller. Here the data is converted to Morse code form and then displayed on the LCD in this form. Also with each dot and dash displayed on the LCD, buzzer is played with proper time delay.

PS/2 keyboard functioning

The Keyboard sends the Scan Code of the key pressed. Code in the microcontroller deciphers the Data received and determines the key pressed. 6-pin Mini Din PS-2 female socket was used to interface the keyboard to Atmega16.

LCD functioning

On the transmitter side the LCD connected to PORTA displays the alphabets and numbers input through the keyboard. On the receiving side the LCD again connected to PORTA displays the Morse code form of the data input through the keyboard.

UART description

Universal asynchronous receiver and transmitter is the hardware in-built in Atmega16 which helps in communication with other microcontroller. In our project we have used it to transmit the character received from the PS-2 Keyboard to another microcontroller where it is converted to Morse code.
The protocol used was:-
1 Start Bit (Logic 0)
8 Data Bits
1 Stop Bit (Logic 1)
No Parity

Programming for Transmitter

Protocol for data transfer from the keyboard is
1 Start Bit (0V)
8 Data Bits
1 Odd Parity Bit
1 Stop Bit (5V)
Data reception is handled through INT 0 falling edge interrupt. The interrupt would be called at every falling edge of the clock cycle and the data is stored in an unsigned char variable. The data is then decoded and the corresponding character is stored in a buffer of 64 bytes. The data is acquired from the buffer and displayed on the CLCD. UART is enabled as a Transmitter with baud rate of 9600. Data is transmitted to the receiver.

Programming for Receiver

UART is enabled as a Receiver with Rx Interrupt enabled, receiver buffer of 8 bytes and 9600 baud rate. CVAVR Code wizard generated the code for putting the characters into the buffer as soon as received. Three functions have been written to be used in the receiver:-
Dot()
It displays "." on LCD and sounds the beeper for 250ms .
Dash()
It displays "_" on LCD and sounds the beeper for 750ms.
Morse code ()
Uses switch case and calls the above functions to display the Morse code of the character and at the same time sound the beeper.

Uses and application of device

It can be used to teach Morse code to beginners.
It can be used as a fun game.
In its very advance form it can be used in satellite communication, as in the case of JUGNU (IIT-K Nano satellite).

Future modifications

At present the circuit has been built on bread board, but we plan to make it on a PCB (Printed Circuit Board) designed in EAGLE software.
We also plan to make a Morse code decoder which shall return alphanumeric output corresponding to keyed in dots and dashes.

About the Authors

This project titled 'Morse Code Encoder' is a bona fide work of Tanmay Gupta(10758) and Dinesh Choudhary(10246) under the guidance and supervision of Manish Kumar(Y9317)done as summer project of HAM Hobby Group, SnT Council, IIT Kanpur. These two are interested in learning various aspects of Morse Code Language and other languages like Q Codes.

NERD

Sparrows Change Their Tune to Be Heard in Noisy Cities

by- Shefali Garg (shefali@iitk.ac.in)

Sparrows in San Francisco's Presidio district have changed their tune to soar above the increasing cacophony of car horns and engine rumbles.We've created this artificial world with all this noise - traffic, leaf blowers, air conditioners.A lot of birds are living in these areas and their songs have been affected by the noise.

Just as we raise our voices to be heard when a car speeds past, birds making their homes near busy intersections have to tweet a little louder. But it's more than just whistling the same tune and turning up the volume. Most birds stopped singing some old songs because those ditties couldn't cut through the racket.Even birds from the same species don't sing the same song.Some bird species sing in different dialects just like the way people talk differently if they are from Texas or California or New York, even different parts of New York.

The sparrows warble in low, medium and high frequencies.It's the really low hum where almost all of this human-made noise is -- in this very low bandwidth. The birds can often sing at the top end of that low bandwidth and if there's no traffic around, that's just fine. But if they're singing and there is making a low humming noise the lowest portion of that song gets lost, and the birds can't hear it.So the birds changed their tune.

Songs need to be heard, not just because they sound pretty -- birds use them to talk to each other, warn away rivals and attract mates.

If you go into a bird's territory and play a song from the same species, they think a rival competitor has invaded its territory.

To do the study, the researchers found territories of 20 sparrows in the Presidio where there's lots of traffic, especially in the morning rush hour when the birds do most of their singing.They set up an iPod speaker, shuffled the sparrow songs from 1969 and 2005 and waited for a reaction.The birds responded much more strongly to the current song than to the historic song,with some sparrows flew toward the speaker while chirping a "get out of here" song.

Courtesy- www.sciencedaily.com

A Girl's Brain in Distress

I often feel that I am divided into many
Somatic, Central, Endocrine- all branches of my Company
I am Master of all, yet my own captive
Why? Mr. Hypothalamus is clever and deceptive.

Right now I am sending down a stern decree
To my officers, to engage in a transmitting spree
Neurons, Synapses, Impulses all set to fire
Sympathetic freak will now take over the whole empire.

Heart rate is increasing, there's plenty of perspiration
Axons, muscles, bones all are in intense action
I wonder why I gave an order so irrational

It's the Endocrine that has got me drunk to this level.

Oxytocin, FSH- all are being shot by the Ovarium
Adrenaline is raving up its own pandemonium.
Prolactin and Estrogen are adding to the enchanting secretion
It is a waste of resources, I am so fed up of copulation.

About the Author

The above Science poem is composed by Abhishek Gaurav, an undergraduate second year student in Department of Electrical Engineering, IIT Kanpur. He is interested in administrative and managerial works and is passionate about Dance.

Science Poetry

Devil's Advocate

Technology is a devil incarnate,
Perceptions and prejudices of men who hate;
And accusations of ugliest kind,
Flows freely from witless minds.

SCIENCE LOWERS GOD' one would yell,
'Bring it down' the second entails;
'Human cloning is an ethical sin' another piped,
Altering God's will, the priest are miffed.

The PULSULATING THEORY or THE BIG BANG HYPE,
How could be true sans ADAM and his wife;
For EVE did eat the apple, BIBLE says,
But science proves it to wrong to utter dismay.

Thence arrived a man of science,
With head held high and clear conscience;
Science a product of rational mind,
of endless research of prodigal kinds.

Tis no fight we have here,
For science not a devil we need to fear;
Its a giant ,I do agree,
But one who's set on a philanthropic spree;
For if GOD and DEVIL alongside thrive,
Why does matter and Antimatter create a hype.

Maybe, maybe Science doesn't harness the Soul,
but it creates a world worth living for;
maybe science sometime toes the line,
But that's not a big deal to whine;
For religion has done that no fewer times,

History replete with such heinous crimes.

Its high time to shun our difference,
nags and complaints and move forth hence;
with religious souls and scientific minds we aspire,
To build one day a GALATIC EMPIRE...

About the Author

The above Science poem is composed by Abhinav Bibhu (aabhinav@iitk.ac.in) a first year undergraduate student of Department of Chemical Engineering, IIT Kanpur. He enjoys reading novels and is interested in finances and biology.

Interesting science facts about Andromeda galaxy

Andromeda galaxy, also known as M31, is galaxy located at a distance of about 2.5 million light years, and is therefore the nearest galaxy to our planet .Andromeda galaxy shows a large ring of dust about 75 000 light-years across encircling the centre of the galaxy. Some scientists believe this is the result of a collision with another galaxy in past.

It is estimated that Andromeda galaxy contains around one trillion stars. The Andromeda galaxy is the only galaxy outside the Milky Way visible to the naked eye.

Eventually Andromeda galaxy and Milky way galaxy will collide and this is expected to occur in 4-5 billion years because Andromeda Galaxy is approaching the Milky Way at about 100 to 140 kilometres per second. What will happen when these two collide remains a mystery though many scientists believe this will result in formation of a giant elliptical galaxy. According to 2010 theory Andromeda galaxy was formed out of the collision of two smaller galaxies between 5 and 9 billion years ago.

The Andromeda Galaxy is thought to be less massive compared to our galaxy because it is believed that our galaxy has more dark matter. Supernovae are twice as common in Andromeda galaxy than in Milky way galaxy

Courtesy - sciencefactsandarticles.blogspot.in

The Motion Controller

Introduction and Motivation

Video gaming/ PC gaming is one of the most popular forms of entertainment for many in our age group, isn't it? Conventional game controlling involves the use of a keyboard or a joystick or mouse. Most joysticks today are pretty much keyboard-like, with buttons. What makes them different from a keyboard is the ability to be easily held in hand.

How would the gaming experience be if the game could be controlled by the mere motions of your hand? Much more fun, obviously! And thus was conceived the idea for the project.

Aim of the project

We intended to make a hand held motion sensing device that could be used for controlling games. Breaking down the problem statement, what we needed was the position of the device in space and its orientation at 'every' instant.

Hardware Used

·   Atmega 16
·   3 axis accelerometer
·   2 axis gyroscope
·   Computer (of course!)

Research work done

The project required us to understand the physics behind motion of any object and the math that could help us evaluate its instantaneous state. Apart from this, image processing using OpenCV, and designing moving graphics using OpenGL were entirely new for us. Work had to be done on writing codes for the same

.

Project overview

We decided to divide the project into three stages:

1.The first stage involved evaluating the tilt of the device – orientation, to be precise, using a 3 axis accelerometer and a 2 axis gyroscope.

2.The second stage saw us finding out the 3-D coordinates of the device using a webcam.

3.In the third stage of the project, we combined the two information – that of position and orientation, to simulate the motion of the device on a computer.

Calculation of orientation

An accelerometer basically gives the components of its own acceleration about its axes. However, it gives lot of vibrational noise. So an instantaneous reading from an accelerometer may not give the correct state of the device. However, over a long time, the average value of accelerometer reading gives the correct data of acceleration of the object.

On the other hand, gyroscopes work well – giving angular velocity component about their own axes – over a short interval; while over a longer interval, the gyroscope data keeps drifting farther and farther from the actual state of the object.

As a result, we had to use both of these inertial sensors and use a filter (in code) to get the accurate angles of rotation.

Brief description of technique used

As the axes of sensors would themselves be moving while in operation, we needed to introduce a 3x3 rotation matrix to relate acceleration/angular velocity in this frame to an inertial frame. See http://en.wikipedia.org/wiki/Rotation_matrix for more on rotation matrices.

The gyroscope data was used to evaluate the yaw, pitch and roll, not through direct integration, but by multiplication of this matrix to the small angle-rotation matrix in the gyroscope's (moving non inertial) frame.

Accelerometer readings gave us the components of 'g' about its axes, which was used to estimate the angles rotated – again involving the use of the above matrix.

Filtering - Now, the data from the two needed to be filtered. The filter we designed was loosely based on a complementary filter, the code of which in one dimension would look like

$$\text{angle} = a*(\text{angle} + (\text{Ang.vel\_gyroscope})*dt) + (1\text{-}a)*(\text{angle\_accelerometer})$$

where 'angle' is the angle by which rotation has taken place. This angle has to be updated at every stage. Ang.vel_gyroscope is the angular velocity about the axis of the gyroscope, and angle_accelerometer is the estimated angle from accelerometer data.

In our case, again, it involved certain complex matrix multiplications.

Finding the position

Our motion controller was provided with a ball on its head, and this ball was tracked by a webcam. We used the OpenCV library to write the code. A function 'cvblob' was used to identify the ball on our device. The RGB values of the ball were fed into the program, which
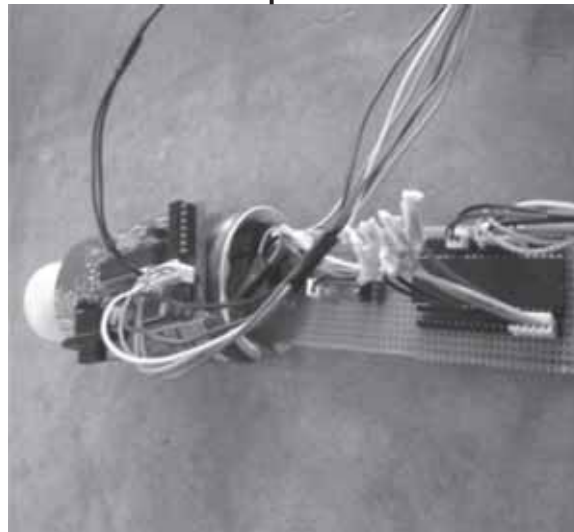
were compared to the image captured by the webcam. The centre of the ball (centroid of the detected 'blob') provided (x,y) coordinates of position while the change in radius (size) of the image gave us the 'depth' of the ball.

Designing of graphics

A software by the name 'Blender' was used to design the virtual object that would simulate the movement of our device on screen. This 'object' was exported to the main code in OpenGL.

Data about orientation was taken from the microcontroller using UART communication. This data had three parts – yaw, roll and pitch.

Now the graphical object could be laterally moved about by changing the origin (according to position data) and oriented in the required manner (using data of yaw, roll and pitch).

Conclusion and future scope

The graphics designed were seen to be responding very well to movement of the motion controller. As an improvement, Kalman filter can be used. This would require a bit more mathematical background as the calculations are for a non-linear model.

The working project can be seen on this link: http://www.youtube.com/watch?v=nmb3kKXg0dA
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About the author

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Science Communication workshop for PhD students

NERD (in collaboration with Centre for Development of Technical Education (CDTE), IIT Kanpur) organised a science communication workshop for PhD students during March 22-25, 2012. The workshop was conducted by Dr. Geoff Hyde, Coordinator of Science Communication unit at NCBS (National Centre for Biological Sciences). The inaugural lecture was open to whole IIT-K community and the event saw a huge attendance of both students as well as faculty members. In this lecture, Dr. Hyde explained the art of storytelling and its different facets. The event was telecasted live at different science and engineering colleges all over the country including IITs and NITs.

The workshop started from March 23. The first one and a half day focussed on speaking skills. Participants were asked to narrate an incident from their life and Dr. Hyde used to give them suggestions on how to do that in the most interesting way. They were further asked to explain their research to others in the most comprehensive way.

The rest of the workshop focused on writing skills. All the participants were logged in to Science Communication course website of NCBS and exercises on writing skills were made available to them. After each exercise, Dr. Hyde personally gave feedback to each participant.

These exercises would continue till May 7, 2012. By every weekend, participants are required to complete a certain set of exercises available on NCBS course website and the following Monday afternoon, each participant receive personal feedback from Dr. Hyde over video conferencing, in addition to regular Emails.

Discussions are going on to make such courses mandatory for our students, especially postgraduates.

Theorion's Deceptive Attack

"Dangerous, very dangerous", murmured Dr .Fred Symonds, as he was shown the medical records of yet another subject. He was in no mood for yet another case of paranoid schizophrenia, and the previous evening spent at his ex-spouse's house did no good to alleviate his mood.

But he was the hope, one must say, the only hope for this case, like many other cases. Awarded the Nobel Prize for physiology for his path breaking research on drugs that induced self-mutation of the genes responsible for the silent killer that wasted many a lives, he was always hailed as the messiah amongst the medical fraternity .But this work had taken a toll on his personal life. The doctor often wondered whether hallucinating was better than living in painful reality, but could never come up with an explanation...

"Sir, what are the hopes for this one?" chirped Ingrid Jones, his dedicated, but sometimes annoying student. The doctor started. He had been dreaming for quite some time."Ah! Let me take a closer look", replied the "Nobel" man, and immersed himself in the study of his newest subject.

The "subject" was Matthew Daeman, a young locksmith. He had been leading a peaceful life until 25, when he displayed the first signs of being schizophrenic. He did not speak, did not write. All he did was draw strange looking symbols. In two years, his life had turned topsy-turvy, and he seemed to be nothing more than a cryptographic machine. He was said to be a locksmith of excellent precision, and his customers included Vicar Locks, the premium lock supplier of Nevada. When he first showed symptoms of schizophrenia, he was working on a new set of 13-lever based locks. When the first consignment was shipped, the people were simply amazed. The locks looked super human, and it seemed that no amount of hair splitting could actually break the combination of these levers.

But more surprise was in store for them. When they contacted the brokers for more consignments, they got some extraordinary news. Daeman, they were told, was obsessed with making and breaking lock combinations. His neighbours were afraid of him, complaining that he talked to the "devils" and made strange signs on the town hall board at night, which he promptly removed before daybreak. Those who saw those signs swore they were written in the language of the devil.

It was the mention of the devil that upset Dr. Symonds.

"Why couldn't people have empathy for victims of mental disorders," he thought. "Anyway", he thought, "this is quite intriguing." When he went through some of the symbols the man had drawn, he had a sense of déjà vu. It seemed that they pointed towards something, but what?

"I think this subject warrants personal attention," he told Jones. Jones did some permutation -combination with the doctor's schedule and finally declared, "After the lecture to the sophomores in Reno tomorrow evening, you have dinner scheduled with the CEO of TEVA. You can visit the "facility" before that."

The doctor smiled. At least he could spend some time with the modern day Scherbius. No doubt he himself was a "cryptologist" in his own right, but still it fascinated him how people created artificial encoding schemes. This case was particularly interesting as the man had been proved a mental retard by every eminent psychologist and was recommended for his famed gene mutation therapy.

The lecture at Reno went well, and the doctor was able to drift many a minds towards the nuances of neuroscience. Now the time had come when he would meet the strange locksmith. He did not know what, but there was something that was making him uncomfortable. "This subject is somehow linked to me," he thought while sitting in his car.

He directed the driver straight to the "facility". Thoughts of his research flashed back and forth during the journey. The link between his career and Daeman strengthened with every passing minute, and the doctor's heart beat increased.

He arrived at the "facility" and was escorted to the ward of Matthew Daemen. He requested his escort to grant them privacy. Once alone, his nervousness increased, and he felt he was nearing paranoia. He was barely keeping himself at peace.

"Sit down, professor," said a voice. The doctor was startled. Nobody called him professor and nobody commanded him. But he complied. He sat on the chair near Daeman's bed, but dared not look into his eyes.

"I must say it was very kind of you to come here. For this task, I trust nobody but you. Please relax, as my intention is not to harm. You alone can understand why I am here and what my intentions are," said Daeman. His voice was soothing, almost reassuring.

The doctor relaxed, but his feeling of something ominous coming up did not subside. Suddenly Daeman's cryptograms seemed to be very familiar. His voice trembled, "You are feigning madness, aren't you? You have managed to fool everyone. But why did you do this?"

"So you now understand what I am going to tell you. Yes professor, you have deciphered the best form of cryptology ever devised. But I have done even better. I have manipulated "those" symbols better than anyone could have. But I could not rely upon anyone but you to broadcast the decrypted message."

The doctor perspired. But the technology was patented by him. How could he..."I was destined to break the code. It was divine intervention. Your scheme of causing mutation by insertion works in the same way as the AES round key expansion. But one wrong crystal fragment can cause wrong results in 10000 other genes. I demonstrated that in my final consignment to the Vicars, who failed to crack that 13 is the smallest prime number less than the square root of 256".

Now the doctor knew. He had to contact Albert immediately.

Albert, or Albert Castillo, was the owner of the largest ranch in Nevada. Nobody except a few knew that this redneck cowboy was the supervisor of Area 51. "They too failed to notice this. How could they?" he thought as his car dashed off to Castillo's ranch.

"Evening, Fred," greeted Castillo, as he saw the doctor coming. But the doctor was in no mood to exchange pleasantries. "It's about Hardy-Ramanujan," he said, referring to their code of Area 51. "We have interpreted the code incorrectly."

Albert quickly changed his demeanour to a serious one. "But how can that go wrong? We have scrutinised it in every possible way."

"The encryption is wrong. The whole pattern has been shifted by one bit," said the doctor, not knowing whether he should be relaxed.

The whole thing dawned upon Albert. How could they be so stupid? He knew he was wrong to proceed without that last bit. After listening to the whole story of the blacksmith and the strange cryptograms, he got that last bit too. Hence, the world would not end in 2012, but 12012. The whole rescue mission going on in Area 51 was a waste of time and manpower.

"Oh! How clever! The whole thing proved to be a storm in the teacup. But how did the cryptogram of the aliens land with the blacksmith? There has been a breach somewhere."

How did the breach occur? What did the locksmith mean by divine intervention? How could he find the loophole in the gene insertion algorithm? In a flash, the doctor understood everything. As he got the meaning of 'divine', the greatness of the revelation made him dizzy. The paranormal had struck again, and their days were numbered....

About the Author

The above story by Abhijit Sharang (abhisg@iitk.ac.in) won Second prize in Science fiction writing competition of Takneek, 2011 (Intra-IITK Sci-Tech competition). Abhijit is a second year undergraduate student in the Department of Computer Science and Engineering. His research interests include psychology, artificial intelligence and cognitive science.

CREATE, COMMUNICATE, CONTRIBUTE !

THE GALILEAN

Note: Some words in this article are used in archaic sense. For example, 'rectangle' at some places means 'product of unequal lengths' and 'square' means product of 'equal lengths'.

A projectile, defined as an object capable of being propelled by a force and continuing in motion by virtue of its kinetic energy, once was not as elementary and concise as we know it now. Instead it was highly debatable topic and many mathematicians and physicist came up with their theories to describe the projectile motion. Most of them had some or other flaw in it but all of them paved way for their successors. One such theory was given by the Italian astronomer and mathematician Galileo Galilei. Galileo postulated theorems and propositions to relate the various components of projectile motion and to compute its trajectory, which he proved entirely using fundamentals of geometry. One such basic theorem is given here along with its geometric proof.

Theorem:-
A projectile which is carried by a uniform horizontal motion compounded with a naturally accelerated vertical motion describes a path which is a semi-parabola.

Before we proceed to the theorem, there are two basic properties of parabola that had been given by Apollonius which would be needed for our discussion. Let us derive the first property from the mode of generation of the parabola and prove the second immediately from the first.
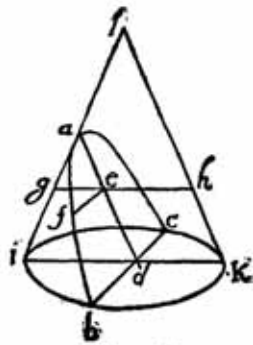
Beginning now with the first, imagine a cone, erected upon the base ibkc with its apex at l. The section of this cone made by a plane drawn parallel to the side lk is a parabola. The base of the parabola bc cuts the diameter ik of the circle ibkc at right angles, and the axis ad is parallel to the side lk; from any point f in the curve

Fig. 106

bfa draw the straight line fe parallel to bd; then, the square of bd is to the square of fe in the same ratio as the axis ad is to the portion ae . Through the point e pass a plane parallel to the circle ibkc, producing in the cone a circular section whose diameter is the line geh. Since bd is at right angles to ik in the circle ibk, the square of bd is equal to the rectangle formed by id and dk; so also in the upper circle which passes through the points gfh, the square of fe is equal to the rectangle formed by ge and eh; hence the square of bd is to the square of fe as id.dk is to ge.eh. And since the line ed is parallel to hk, the line eh, being parallel to dk, is equal to it; therefore id.dk is to ge.eh as id is to ge, that is, as da is to ae; whence also id.dk is to ge.eh, that is, the square of bd is to the square of fe, as the axis da is to the portion ae.
q. e. d.

The other proposition necessary for this discussion is demonstrated as follows.

Let us draw a parabola whose axis ca is prolonged upwards to a point d; from any point b draw the line bc parallel to the base of
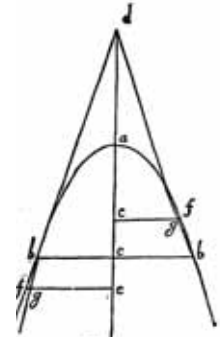

Fig. 107

the parabola; if now the point d is chosen so that da = ca, then, the straight line drawn through the points b and d will be tangent to the parabola at b. Let us assume that this line cuts the parabola above or that its prolongation cuts it below, and through any point g in it draw the straight line fge. And since the square of fe is greater than the square of ge, the square of fe will bear a greater ratio to the square of bc than the square of ge to that of bc; and since, by the preceding proposition, the square of fe is to that of bc as the line ea is to ca, it follows that the line ea will bear to the line ca a greater ratio than the square of ge to that of bc, or, than the square of ed to that of cd (the sides of the triangles deg and dcb being proportional). But the line ea is to ca, or da, in the same ratio as four times ea.ad is to four times the square of ad, or, what is the same, the square of cd, since this is four times the square of ad; hence four times ea.ad bears to the square of cd a greater ratio than the square of ed to the square of cd; but that would make four times ea.ad greater than the square of ed; which is false, the fact being just the opposite, because the two portions ea and ad of the line ed are not equal. Therefore the line db touches the parabola without cutting it.
q. e. d.

The fact, that four times ea.ad is less than the square of de because the two portions ea and ad of the line de are not equal , is one of the Euclid's theorem which states that when a line is cut into equal and also into two unequal parts, the rectangle formed on the unequal parts is less than that formed on the equal (i. e., less than the square on half the line), by an amount which is the square of the difference between the equal and unequal segments. From this it is clear that the square of the whole line which is equal to four times the square of the half is greater than four times the rectangle of the unequal parts. Now we resume to our

theorem and see that a body falling with a motion compounded of a uniform horizontal and a naturally accelerated vertical one describes a semi-parabola.

Let us imagine an elevated horizontal line or plane ab along which a body moves with uniform speed from a to b. Suppose this plane was to end abruptly at b; then at this point the body will, on account of its weight, also acquire a natural motion downwards along the perpendicular bn. Draw the line be along the plane ba to represent
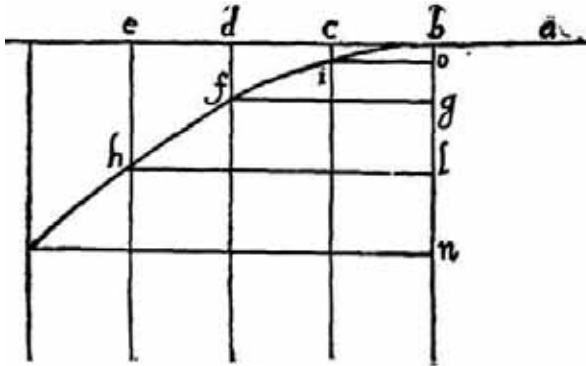

Fig. 108

the flow, or measure, of time; divide this line into a number of segments, bc, cd, de, representing equal intervals of time; from the points b, c, d, e, let fall lines which are parallel to the perpendicular bn. On the first of these lay off any distance ci, on the second a distance four times as long, df; on the third, one nine times as long, eh; and so on, in proportion to the squares of cb, db, eb, or, we may say, in the squared ratio of these same lines. Accordingly we see that while the body moves from b to c with uniform speed, it also falls perpendicularly through the distance ci, and at the end of the time interval bc finds itself at the point i. Similarly at the end of the

time-interval bd, which is the double of bc, the vertical fall will be four times the first distance ci; for it has been known that the distance traversed by a freely falling body varies as the square of the time; in like manner the space eh traversed during the time be will be nine times ci; thus it is evident that the distances eh, df, ci will be to

one another as the squares of the lines be, bd, bc. Now from the points i, f, h draw the straight lines io, fg, hl parallel to be; these lines hl, fg, io are equal to eb, db and cb, respectively; so also are the lines bo, bg, bl respectively equal to ci, df, and eh. The square of hl is to that of fg as the line lb is to bg; and the square of fg is to that of io as gb is to bo; therefore the points i, f, h, lie on one and the same parabola. Similarly , if we take equal time intervals of any size whatever, and if we imagine the particle to be carried by a similar compound motion, the positions of this particle, at the ends of these time-intervals, will lie on one and the same parabola.

q. e. d.

This conclusion follows from the converse of the first of the two propositions given above. For, having drawn a parabola through the points b and h, any other two points, f and i, not falling on the parabola must lie either within or without; consequently the line fg is either longer or shorter than the line which terminates on the parabola. Therefore the square of hl will not bear to the square of fg the same ratio as the line lb to bg, but a greater or smaller; the fact is, however, that the square of hl does bear this same ratio to the square of fg. Hence the point f does lie on the parabola, and so do all the others.

As the proof rests on the hypothesis, that the horizontal motion remains uniform, that the vertical motion continues to be accelerated downwards in proportion to the square of the time, and that such motions and velocities as these combine without altering, disturbing, or hindering each other, so that as the motion proceeds the path of the projectile does not change into a different curve, one may come across certain difficulties with the proof of the theorem such as :-

1) The axis of the parabola along which we imagine the natural motion of a falling body to take place stands perpendicular to a horizontal surface and ends at the center of the earth; and since the parabola deviates more and more from its axis no projectile can ever reach the center of the earth or, if it does, as seems necessary, then the path of the projectile must transform itself into some other curve very different from the parabola.

2) We suppose the horizontal plane, which slopes neither up nor down, to be represented by a straight line as if each point on this line were equally distant from the center, which is not the case; for as one starts from the middle [of the line] and goes toward either end, he/she departs farther and farther from the center [of the earth] and is therefore constantly going uphill. Whence it follows that the motion cannot remain uniform through any distance whatever, but must continually diminish.

3) The resistance of the medium must destroy the uniformity of the horizontal motion and change the law of acceleration of falling bodies.

Galileo has taken all these difficulties into account and has provided fascinating explanations for each of the problem. For the first two problems Galileo has argued using the principles that had been given by Archimedes and his other predecessors. In his Mechanics and in his first quadrature of the parabola Archimedes takes for granted that the beam of a balance or steelyard is a straight line, every point of which is equidistant from the common center of all heavy bodies, and that the cords by which heavy bodies are suspended are parallel to each other. Some consider this assumption permissible because, in

practice, our instruments and the distances involved are so small in comparison with the enormous distance from the center of the earth that we may consider a minute of arc on a great circle as a straight line, and may regard the perpendiculars let fall from its two extremities as parallel. In all their discussions Archimedes and the others considered themselves as located at an infinite distance from the center of the earth, in which case their assumptions were not false, and therefore their conclusions were absolutely correct. When we wish to apply our proven conclusions to distances which, though finite, are very large, it is necessary for us to infer, on the basis of demonstrated truth, what correction is to be made for the fact that our distance from the center of the earth is not really infinite, but merely very great in comparison with the small dimensions of our apparatus. The largest of these will be the range of our projectiles—and even here we need consider only the artillery—which, however great, will never exceed four of those miles of which as many thousand separate us from the center of the earth; and since these paths terminate upon the surface of the earth only very slight changes can take place in their parabolic figure which, it is conceded, would be greatly altered if they terminated at the center of the earth. As for the problem concerning the resistance due to the medium; the resistance of the air exhibits itself in two ways: first by offering greater impedance to less dense than to very dense bodies, and second, by offering greater resistance to a body in rapid motion than to the same body in slow motion. Regarding the first of these, consider the case of two balls having the same dimensions, but one weighing ten or twelve times as much as the other; one, say, of lead, the other of oak, both allowed to fall from an elevation of 150 or 200 cubits.

Experiment shows that they will reach the earth with slight difference in speed, showing us that in both cases the retardation caused by the air is small; for if both balls start at the same moment and at the same elevation, and if the leaden one be slightly retarded and the wooden one greatly retarded, then the former ought to reach the earth a considerable distance in advance of the latter, since it is ten times as heavy. But this does not happen; indeed, the gain in distance of one over the other does not amount to the hundredth part of the entire fall. And in the case of a ball of stone weighing only a third or half as much as one of lead, the difference in their times of reaching the earth will be scarcely noticeable. Now since the speed acquired by a leaden ball in falling from a height of 200 cubits is so great that if the motion remained uniform the ball would, in an interval of time equal to that of the fall, traverse 400 cubits, and since this speed is so considerable in comparison with those which, by use of bows or other machines except fire arms, we are able to give to our projectiles, it follows that we may,

without sensible error, regard as absolutely true those propositions which we are about to prove without considering the resistance of the medium. Passing now to the second case, where we have to show that the resistance of the air for a rapidly moving body is not very much greater than for one moving slowly, ample proof is given by the following experiment. Attach to two threads of equal length—say four or five yards—two equal leaden balls and suspend them from the ceiling; now pull them aside from the perpendicular, the one through 80 or more degrees, the other through not more than four or five degrees; so that, when set free, the one falls, passes through the perpendicular, and describes large but slowly decreasing arcs of 160, 150, 140 degrees, etc.; the other swinging through small and also slowly diminishing arcs of 10, 8, 6, degrees, etc. In the first place it must be remarked that one pendulum passes through its arcs of 180°, 160°, etc., in the same time that the other swings through its 10°, 8°, etc., from which it follows that the speed of the first ball is 16 and 18 times greater than that of the second. Accordingly, if the air offers more resistance to the high speed than to the low, the frequency of vibration in the large arcs of 180° or 160°, etc., ought to be less than in the small arcs of 10°, 8°, 4°, etc., and even less than in arcs of 2°, or 1°; but this prediction is not verified by experiment; because if two persons start to count the vibrations, the one the large, the other the small, they will discover that after counting tens and even hundreds they will not differ by a single vibration, not even by a fraction of one. This observation justifies the two following propositions, namely, that vibrations of very large and very small amplitude all occupy the same time and the resistance of the air does not affect the motions of high speed more than those of low speed, contrary to the opinion hitherto generally entertained.

These examples demonstrate the importance of the theorem and its applications. Though we no longer study the Galilean mechanics it was of immense importance for all of the scientific improvements that followed in the late seventeenth century, as the English physicist and mathematician Sir Isaac Newton once said that, "If I have seen farther, it is by standing on the shoulders of giants" , which precisely states the importance of evolution of science.

Main reference:-
Dialogues concerning two new sciences, by Galileo Galilei.

About the Author

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Interview

The joy of basic science research

Interview with Dr. Milan Sanyal

Professor Milan Sanyal is an eminent Indian physicist in fields of nano science and surface physics. A Fellow of all three major science academies of India, he is the Director of Saha Institute of Nuclear Physics, a basic research institution working in Physics and Bio-physics. NERD team had the privilege to have an exclusive interview with him as a scientist and an active member in the Indian scientific community. Here are some excerpts of the same:

NERD: Sir, you have been associated with SINP (Saha Institute of Nuclear Physics) for 15 years. What is the most distinguishing feature you feel about the institute?

Dr. Sanyal: The institute only concentrates on basic research – if the research conducted here finds an application, it is nice – but that is not the guiding force, because mostly one gives too much thought to the application right when one begins to do basic research that the vision gets myopic. For example, when Michael Faraday invented generation of electricity, no one knew for what purpose electricity would be used for. He was actually asked to stop his research, because it was felt at that time that electricity was not useful; and now you look at today's situation - without electricity, the whole world will collapse. So, the good part of SINP is that we are not too much bothered about the application of our research in the beginning. We are not against application – of course, we favor it- but our research activity is not controlled by some known applications. I differentiate between known application and unknown application, and believe that most of the major applications came out when the application was unknown, just as in the case of electricity.

NERD: You are the present director of SINP. Please tell us more about the institute, its major research interests, recent initiatives and its worldwide ranking in state of art research.

Dr. Sanyal: This institute was founded by Prof. Megnad Saha - one of the greatest scientists of our country. He is well known for famous Saha equation used in astrophysics, plasma physics and many other fields. He

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was even nominated for Noble Prize in 1930 along with Prof. C V Raman.

He thought to start an institute with a very close association with a teaching university because he knew, from the very beginning, that without including students, one cannot have this kind of basic research; so he was very careful about some aspects. Firstly, this institute should be a National Institute so he restricted the entry of our post M.Sc. students from West Bengal to a certain level, to have students from other states as well. He wanted this institute to be an International level institute, so he set up a post M.Sc. course- that is the oldest in our country. People after MSc join this course and then join the research program here. The institute was inaugurated by Irin Curie, the daughter of Marie Curie.

We are working on majorly five subjects in this institute - nuclear physics and particle physics, condensed matter physics, surface physics and nano-science, bio-physics and bio-chemistry, plasma physics and finally electronics.

NERD: You have been interested in surface physics, and have been the Head of Surface Physics Division at SINP. Can you, in simple terms, explain our readers the fundamentals of surface physics and your research interests in the field?

Dr. Sanyal: The activities in surface physics in this institute I started when I joined the institute in 1995. We started with simple laboratories – one of our earlier papers in Physical Review Letters was about a 2D Cadmimum Sulphide (CdS) formation of thickness 14 Angstrom

Surface physics is very important for semi-conductor

research, soft materials and polymers. The material which we can fill on the top of any material is on its surface. Atoms that are at the top, find two different environments - one side it is vacuum or air, while the other side it is the material itself, hence the topmost atoms organize themselves in a different way and this changes the property of the surface. This aspect becomes even more important if we go to nanomaterials (materials that have one of the dimensions less than 100 nm) because most of the atoms or molecules will be on the surface of the material itself.

NERD: How is the surface physics of metallic films different from that of fluids?

Dr. Sanyal: This is a very interesting question. If we talk about solids, we talk about roughness. Roughness can be on a macroscopic level - it can be a wavy thing on the surface, as on a mirror. When you think about roughness at the atomic length scale, this is a very important property for several applications, such as lubrication and catalysis. Also, roughness of material has two types- dynamic and static. For liquids, it is dynamic roughness because their surfaces are moving, but for solids, it's the static roughness- that is the basic difference.

NERD: You have also been recently working on structure-function relationship in nanomaterials. Please tell us more about this relationship and how does it affect the applications of nanomaterials.

Dr. Sanyal: We studied in our school that the functional properties of a material are independent of its shape and size- so whether it's a gold wire or a gold ball, it remains a metal and it will be shiny. Now when you talk of nanometer length scales, it starts changing its property, and hence the property of a material at its nano-scale depends on its structure, size and shape. Unless you characterize all the three parameters in great detail, you cannot study the properties, because the property changes with a change in any of these three parameters.

When I talk about structure-property relationship, we are essentially playing with parameters of shape and size, keeping the structure same, and noting the change in property. It is fascinating physics. Also, there is related work on low dimensional materials in early 70s. Low dimensional material is one whose one or more dimensions are too small as compared to the other, for instance, a material that has only one layer of

molecules can be said to be a two-dimensional material and an atomic wire is a one-dimensional material. However these low dimensional materials are actually quasi-low dimensional material. Such materials can be worked upon very fantastically with the nanomaterials, hence it is so easy to grow and you can test out so many theoretical ideas all at once.

NERD: What are Langmuir Blodgett (LB) films? What properties of these films are studied using X ray scattering and Atomic Force Microscopy (AFM)?

Dr. Sanyal: Langmuir and Blodgett found out that if we spread an immiscible liquid on the surface of water, it will come on the surface of the water and then it becomes like a two-dimensional material. You can actually lift it up on a surface, and create a multi-layer of this kind of film. This is a very important result for physics, chemistry and biology.
The molecule we use here has actually two parts- one is hydrophilic (it likes water) and the other hydrophobic, hence the molecule stands up and if we lift the film, you can form a multi-layer film. Pressure-area characteristics of these films are also being studied.

"I like science because I am paid for my hobby. I do whatever I like and get paid. In any other job, one is told that one has to do this and even if one doesn't like to do that, one has to do it for securing one's salary."

NERD: You have been doing synchrotron studies of liquid surface and magnetic structure. What is the concept behind these synchrotron studies and what surface information do they give?

Dr. Sanyal: Synchrotron is an accelerator where you can rotate electron or positron at a very high energy. It is like a cyclotron but in cyclotron, you can also rotate ions, and here you mostly rotate electron. According to electromagnetic theory, whenever a charged particle is rotated, it will emit radiation. This radiation is the synchrotron radiation, whose energy varies from infrared to very high energy. You can also use a monochromator to select a particular energy level and can get, for instance, an X-ray beam that is used to study surfaces of nanomaterials, interfaces and even standard materials. These X-ray beams are around 106 times more intense than the laboratory X-ray. You can scan the entire surface of the material using the 100 keV X-ray beam available now. It has only 30 nm dimension, so it is very fine and narrow like laser.

NERD: Center for Astroparticle Physics (CAPP) seems to be the most recent center started by the institute. Can you elaborate on the initiative and some questions this center is trying to address?

Dr. Sanyal: Prof. Meghnad Saha, who started this institute, was a giant figure in astrophysics. We will be having the Diamond Jubilee of our institute next year, so we are starting a center related to astrophysics, where we will not only have the theoretical aspect, but also experimental facilities. I believe we should open our institute for students visit, as well as for people from other cities, because astrophysics is something that catches the student mind very quickly. Also we are hiring new faculty and installing good telescopes to have a better interaction with the student community.

NERD: You are an elected fellow of all three science academies in India. You also received the Medal of Material Research Society, India. What, in your opinion, is your most significant contribution and its application in your research area?

Dr. Sanyal: Of course, I am very proud to be the fellow of all the three science academies of our country. I believe my best contribution is yet to come, but the most important till now has been the scattering of light from the surface and interfaces. I, with my student A. Rehman, have shown that in a polymer nano-wire, Weigner solid (one-dimensional solid cab) formation occurs. Weigner solid is a very peculiar thing, because theoretically, it was thought that electrons repel each other but if you have lot of electrons, this repulsion will not be felt due to the screening effect. One electron doesn't feel the other because of the crowd. But if the crowd is reduced, there are a very small number of electrons in a very big space, and then they separate out themselves to form a lattice of electrons – an electron solid. We found that such lattice could be found on polymer nano-wire. Therefore, the liquid surface and Weigner crystallization are the two of my works that I put on the top.

NERD: What are the various opportunities students at undergraduate, masters or doctoral level can avail at SINP?

Dr. Sanyal: We have a MN Saha associateship program. Students, just after their schooling, can apply for this. Depending on their scores in national exams like JEE and board examinations marks, we select some of the fellows, and they remain associated with us for next five years - they can come at SINP during summers for working, and we pay them quite handsome grants. We also have a PhD program – the main driving force for our research. Besides, we have post doctoral fellows, visiting scientists, and faculty members working with us.

NERD: You pursued your B.Sc., M.Sc. and Ph.D. in physics. Were you always sure to purse research in your career?

Dr. Sanyal: I was fortunate to be selected in Bhabha Atomic Research Centre in early years as a scientific officer. I like science because I am paid for my hobby. I do whatever I like and get paid. In any other job, one is told that one has to do this and even if one doesn't like to do that, one has to do it for securing one's salary.

NERD: Where do you see India on the global map of nuclear physics by 2020?

Dr. Sanyal: It depends on you all engineers. I believe that India can generate best human resource in the field of science and technology. Any country develops when basic science as well as engineering and application is done. In fact, the best use of basic science has been done by the IT. It is a common feeling that many people have left basic research because of IT, but I believe it has had its own impact – it's due to the IT that government has fantastic revenue and it can fund research centers better, so we cannot segregate the contribution of anyone. All we have to make sure is that when you are noticed as an individual, it's due to your knowledge and not due to your money. Money will automatically come if you have knowledge - no matter what subject. I firmly believe India has a big future- be it Nuclear Physics or any other field – because we are becoming a knowledgeable nation.

NERD: How will you describe Dr. Milan Sanyal in one line?

Dr. Sanyal: One who is attracted by knowledge, and always looks for a good problem for his basic research.

NERD: What is your final message for students?

Dr. Sanyal: Our students are very gifted, and my message to them is that they should choose any subject according to their interest and aim to reach the top in that. If someone asks me what the best thing in India is, my answer is parents, because they sacrifice many things for their children, that's why our children are very well nourished and they do whatever they want to do.

Thank you so much sir.

"It's due to the IT that government has fantastic revenue and it can fund research centers better, so we cannot segregate the contribution of anyone. All we have to make sure is that when you are noticed as an individual, it's due to your knowledge and not due to your money. Money will automatically come if you have knowledge - no matter what subject."

SOUND AND LIGHT

This puzzles contains 52 words related to " Sound and Light ". Try to find them.

B	C	A	L	L	C	O	C	W	A	V	E	J	K	H	U	T	W	Y	E	F	B	D	R
A	M	I	C	I	E	O	P	O	D	B	N	A	Y	A	S	O	A	D	O	Y	I	E	E
D	Y	U	N	O	G	B	N	A	L	H	F	Q	P	E	B	R	U	C	B	F	F	V	Q
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A VANET Based Cooperative Collision Avoidance System for a 4-Lane Highway

INTRODUCTION

Road accidents are a leading cause of casualties nowadays, and they result in huge economic loss as well. Visual obstructions and recklessness of the drivers are the potential causes of accidents that we intend to prevent. Vehicular Ad-hoc network (VANET) is basically a car-to-car and car-to-infrastructure wireless communication network where vehicles are treated as 'smart objects'. It aims towards safer and more efficient transportation system by providing timely and reliable information to drivers and concerned authorities. This paper is concerned with only car-to-car communication that reduces the need for roadside units by allowing the vehicles to communicate critical information directly with one another, thereby warding off the risk of likely collisions. In this paper, we have presented a basic design of a "Collision Avoidance Car-to-Car Communication" for a complex scenario of 4-lane highway that can be integrated in a car-to-car communication system to give an effective and high end transport solution. For quick and efficient handling of safety messages, a message handling algorithm based on priority queue using Linked List has been presented. Moreover, a priority function that takes advantage of the parameters like relative distance and relative velocity has been introduced to assign a priority to the various incoming messages for avoiding any ambiguity in decision-making by the system. Since introduction of security is of great importance in VANETs, so we have covered the problem of wirelessly security theoretically while checking the authenticity of the incoming messages.
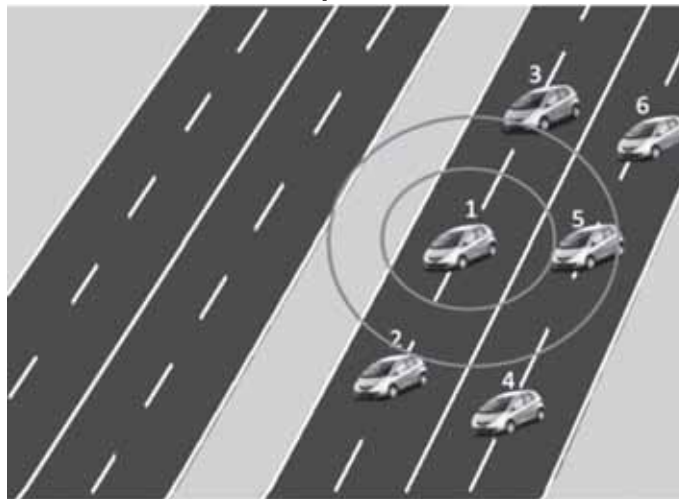
PROBLEM STATEMENT

A small vehicular ad-hoc network is created where each vehicle will transmit and receive data relating to speed and location. This information will be obtained through the on-board unit of each vehicle. Each of these units will utilize GPS to obtain location and the vehicle's on board diagnostics (OBD-II) to find speed. A transceiver in these units will transmit this information to nearby vehicles and also obtain data from surrounding vehicles, all at sufficient rates to be useful for increasing driver safety. The IEEE 802.11p protocol is used to get the efficient high speed communication.

THE SCENARIO

The designed system will solve several of the situations on a 4-lane highway but first here is some general information describing the overall system. There are six cars driving on either side of the 4-lane Highway as shown in Fig 1. These cars are at several car-lengths apart and are travelling with speeds varying between 60-120kmph. The situation is such that the car ahead of the host car (car no. 1) breaks hard meaning there is a considerable amount of deceleration. The cars following the front car will be warned that there is a possibility of an accident. The other cars will receive the broadcasted data that accounts for the braking car, but only the car in danger of colliding will receive an 'alert signal' to warn the driver of an accident. The driver of the car in front of the braking car will not be warned to brake because it is safe, but the front car (i.e. car no. 2) will be warned in case the host car decides to overtake it by changing the lane in order to avoid the accident. In our current model, we define the lane size to have a width of 6 meters to take into account the error in GPS data. The information being collected includes location and speed that will be consolidated into packets to be sent broadband-wirelessly.

. DESIGN

The Car to Car Communication interface requires complete integration between the GPS, OBD-II, and transceiver on each vehicular module. We use a microcontroller to fit these all together.

1) **Power Supply**: The power supply we are using

draws on the 12 volt supply from the car battery, accessible through the dashboard. This design choice was obvious because all vehicles have them and it frees up the need to make use of external battery sources. The choice however limits our system to components that require 12V or less. Linear regulators will be used to regulate the voltage to lower levels as necessary for each component.

2) Transceiver: DSRC or Dedicated Short Range Communication is a requirement for our transceiver as that is the protocol for automotive use. DSRC offers one or two way communication wireless communication in the 5.8 GHz band. Our use of the microcontroller will need to translate the correct data from the GPS and OBD-II to something useable by the transceiver.

3) GPS: The GPS is used to determine the location of the respective vehicle. The GPS on each vehicle must find its location and send this data to the transceiver. When the GPS satellites broadcast information, the GPS receiver can determine the distance away from each GPS satellite based on the broadcasted information. The GPS receiver does this by using the time a signal takes to travel from the GPS satellite to the GPS receiver based on the broadcasted information and the propagation velocity.

$$d = Vp / \delta t$$

The GPS uses a method called trilateration in determining the location of the GPS. A GPS receiver does not know its direction from a GPS satellite if only one is in view. To determine the location of the GPS receiver, the receiver needs more information. It gets the information it needs to determine the location from the other GPS satellite. A minimum of three satellites are needed for the GPS to operate.

4) OBD-II: On Board Diagnostics are a vehicle's self-diagnostic and reporting ability. Every car has a port within 1 meter of the driver's seat. Our design utilizes the OBD-II to find the speed and of a vehicle. The signal coming from the OBD-II must be sent to the microcontroller unit.

5) Microcontroller: The microcontroller will serve as the interface between all the other components on each vehicular module. Signals coming from both the GPS and OBD-II go through the microcontroller to be sent on to the transceiver. Signals coming from other vehicles will go through the transceiver to the microcontroller for processing.

ALGORITHMS INVOLVED

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Collision Avoidance Algorithm
Srel|= Relative distance between the two cars
ΔV = Vhost – Vother
Here, car 1 is the host car.
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Sign conventions tàken:
If the car is in front of the host car (in either of the two lanes), it will have -ve Srel
If the car is behind the host car (in either of the 2 lanes), it will have +ve Srel
If the other car has a greater speed as compared to the host car, then ΔV will be –ve
If the other car has a lower speed than the host car, then ΔV is +ve.

Assumptions:
Refreshing of messages in the priority table will occur at a particular known frequency.
The range of transceiver has been assumed to be circular and messages of only the cars in range are considered.
In this collision avoidance algorithm, the messages that have been arranged in the priority queue according to their priority will be processed one by one. After receiving the message signal, the relative distance (Srel) is computed and if it is found to be negative, the message is discarded without further processing. It is to be noted that the host car will have to deal only with the cars in front of it in either of the lanes (in our case car2 and car4). It has not to bother about the cars behind it, because we are working on a valid assumption that the probability of collision of the host car is maximum with the nearest cars in the front and intentional collisions from behind are not taken into consideration. When car 3 will be host car its decision to avoid accidents will depend on the parameters of car 1 and car 5 and so on. This forms a chain where each host car decision will depend on the parameters of the nearest front car of each lane. After checking for the relative distance, the relative velocity (ΔV) is looked for as shown in the algorithm and here the driver has the option of braking down by warning the cars behind it, but if ΔV is found to be positive, the comparison of Srel to a safe distance, Ssafe (distance corresponding to normal deceleration of the car) is carried out to check whether the car is in danger zone or not. If it is not in danger zone, it can brake hard and disseminate a warning alert side by side. On the other hand, if it is in the danger zone, the relative distance have been compared again to a critical distance, Scritical (distance corresponding to max. possible braking/deceleration of the car) signifying the extreme danger of a collision where a critical lane change or the warning to the front car can only save the host car. Critical lane change refers to the changing of the lane by the host car and then coming back to its own lane without changing its speed, thereby overtaking the car in front of it, to prevent collision.
NOTE: All parameters have been determined by taking the assumption that speed of the cars ≤ 120kmph

Message Handling Algorithm (PRI, Message)
To arrange the messages reaching to the system we have defined a function named 'priority-function'.

Various messages will be arranged on the basis of max value of the priority function, PRI

PRI= – (Srel*ΔV)

As the message packet arrives, priority-function is called that saves it in a linked list according to its priority. Node 'start' points to the starting node of the list. If 'start' points to null it means the queue is empty and it saves the message packet as the first node. Now if our system receives another message packet within a threshold time interval, the priority-function will be called again and that message packet is saved in the list by comparing its priority with that of existing message packet node. Likewise other message packets arriving within the threshold time will be saved. Now after each threshold time, the system will call the function 'execution'. This function will take the starting node of the linked list as parameter and send the message packets in prioritized order for processing. By processing, we mean that the message will be checked for the condition of collision and warning alarm will trigger accordingly.

PRI⮕ It stores the priority of a particular message i.e. calculated using the parameters-relative distance and relative velocity between the two cars.

Messàge⮕ It stores the message/data i.e. velocity and coordinates of other car.

Computation

After the activation of the system module comprising of the OBD-II, microcontroller and the GPS receiver, the current location of the car is obtained via GPS. The refresh rate of the data is 1Hz, so this clearly implies that all the calculations are to be performed in a time interval ≤ 1s. Simultaneously, the car's speed is fetched from the OBD-II. These statistics of the car are broadcasted wirelessly to other cars in the range via the transceiver and alongside the transceiver gathers various messages (consisting of GPS and OBD-II data of the respective car) disseminated by the cars in the vicinity. But as far as security is concerned, each of the incoming messages has to be checked whether it is secure or is suspicious. Here, CIN stands for car identification number. Every car is assigned a unique CIN so that whenever a message is received, it is checked for its authenticity. The CIN will be verified by a server incorporated in the car's system. If it is authorized, message will be further processed else it will be discarded. After a vehicle receives the speed and location information messages from other cars, calculations are computed, a priority is assigned to each of these messages on the basis of priority function and as a result they are arranged in a queue for further processing. This is followed by the checking of collision probability with the various cars in vicinity. The microcontroller either sends a signal to the buzzer, warning the host driver that it is too close or disseminates a warning alert to the other drivers in danger, or doesn't send a warning message. In this way, all the 'N' vehicles in the vicinity are investigated for the chance of a probable collision or accident, where 'N' denotes the no. of authorized vehicles/nodes in the vicinity of the host car. When all the calculations for a given GPS and OBD data have been done, the co-ordinates of the new location are fetched via GPS, the speed information is obtained through OBD and the entire procedure is repeated again.

Where:

K à No. of incoming messages
CINà Car Identification No.
|Srel| = Relative distance
ΔV= Vhost – Vother
PRIà Priority of a particular message
N à No. of authentic messages
Messàgeà Stores the data i.e. velocity and coordinates of other car

CONCLUSIONS

A basic and effective design of a 'Collision Avoidance Car-to-Car communication system' for a complex scenario of 4-lane highway, which is based on VANETs, has been presented and described in the paper. A message handling algorithm based on priority queue using Linked List and a priority function that takes advantage of the parameters-relative distance and relative velocity has also been proposed. The system will be a lifesaving one in case of foggy weather or in other situations of visual obstructions & recklessness. Our car communication system demonstrates that with enough resources, a much larger scale car to car communication system with an indefinite amount of cars may be possible in the future.

FUTURE WORK

There are many improvements that have been considered for this system. While we realize that GPS has its advantage in terms of navigation, it also has its disadvantages in a safety critical system. The major problem with GPS in this system, other than accuracy, is latency. GPS only updates at a rate of 1Hz; a rate that is quite slow when complex calculations of speed and current location are taking place in order to save lives. However, we could build our system to real world specifications by using a more accurate GPS, say Differential GPS. We also wish to extend our model by making arrangements for the communication between vehicles and roadside units which can also increase safety. Hence, drivers can receive information on traffic flow, road conditions or construction sites directly from the respective road-side unit, thereby enhancing the effectiveness of VANETs.

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This article is one of the winning entries of EUREKA, the paper-presentation competition organised in Techkriti 12 (IIT Kanpur Sci-Tech festival).

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Science & Technology Council Day, 2012

-Harshad Sawhney

Science and Technology Council (SnT Council) is an integral part of IIT Kanpur. Students celebrate Sci-Tech day every year to culminate the last year work done by the council and to honor the students who have contributed to fulfill this purpose. This year, it was celebrated on April 3 in outreach building. The main highlight of the event was the exhibition organized by various SnT clubs displaying their marvelous projects. Aero-modeling club presented their remote controlled planes and explained the aerodynamics behind it to the science enthusiasts who attended this exhibition. Business club presented various case study models and situation of bonds in India.

The projects presented by robotics club kept the people in sheer amazement. They presented projects like Hexa-bot which has six arms, magnetic wall climber which could climb on magnetic walls, robotic arm, spherical bot, rover bot and many more. Rubik's cube hobby group showed different types of cubes and solved them within no time.

Astronomy club presented telescopes built by them and explained its construction. Programming club presented their projects, one of which was based on the game 'Tron'. They also showed hacking demonstrations. Electronics Club presented projects like Ethernet chat client and wireless game controller. These projects reflected the hard work and dedication put by the students of IIT Kanpur to convert innovative ideas to reality.

The exhibition was followed by hovercraft match presented by Aero-modeling club members. It was quite amazing to watch hovercrafts which are air cushioned vehicles and operate by creating a cushion of high pressure air between the hull and the surface below.

This was followed by snacks break. Then the students presented an air show in which tricopters, ornithopters and various other remote controlled planes were flown in the sky. The air show was brilliant and the crowd gave a huge round of applause to appreciate the show.

A ceremony was held after the air show which was inaugurated by Subhojit Ghosh, the new General Secretary, Science and Technology Council. It was followed by a speech by Dr. A.K. Ghosh, Dean of Student Affairs. He encouraged students to participate in various SnT clubs which give a platform to unleash imaginative ideas and think beyond the conventional boundaries. After this all those students who contributed in taking the SnT clubs to new heights were honored.
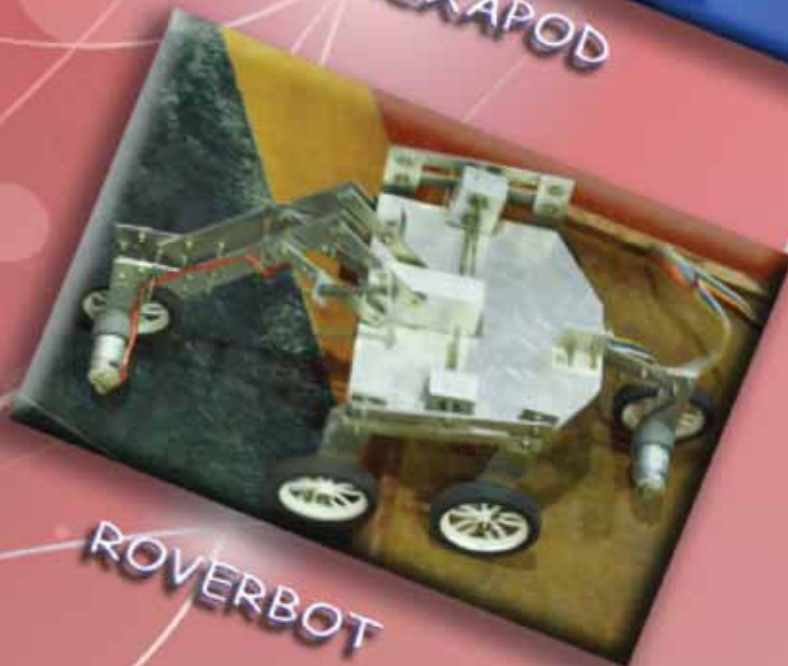
Science
&
Technology
Day

HOVERBOT

HEXAPOD

ROVERBOT

Science Communication workshop for PhD students by Dr. Geoff Hyde

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