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MinION as a Teaching tool in a Graduate course in Pakistan

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Genomics is a rapidly evolving field of study that is increasingly being utilized as a tool to detect ethnic and tribal-specific mutations that may be the key to rare and common diseases with higher prevalence in the population under study [1]. However, researchers and science educators in remote areas can often find it difficult to access the latest genetic technologies, probably due to its high costs and lack of suitable infrastructure. Recent technological innovations are resulting in portable, low-cost instruments that enable next-generation sequencing in remote environments, offering new opportunities to generate a more widespread network of trained geneticists [2]. We need to formalize educational efforts to teach students and young researchers with hands-on training to excel in molecular and bioinformatics knowledge. Here, we report our experience of using the MinION pocket size sequencer in a graduate course. The graduate course had some theoretical lectures that explained the basic principles of genomics followed be practical sessions. We hope that the training material developed during this course will provide the community with useful tools to help educate future generations of genome scientists in Pakistan.

MinION is probably the first commercially available sequencer which uses nanopore technology [3]. It is a small 100gm palm size USB interfaced portable sequencer and can be connected to the computer through USB 3.0 port [4]. As every researcher, from under developing countries like Pakistan cannot afford their very own sequencer (Illumina, Ion torrent or Sanger sequencer etc.) for the research purposes. As the currently available sequencers are not only expensive in cost at the time of purchase but also need a high value maintenance which is also provided by the concerned companies at quietly affective cost. This make nearly impossible to use the advanced expensive technology of sequencing by the researchers at newly developed research facilities. Still there are about seven different institutions in Pakistan that have installed next generation sequencers like Illumina HiSeq, MiSeq, Ion Torrent, 454 etc. Most of them are not functional for the last many years. Keeping insight all these challenges faced by researchers Oxford Nanopore Technologies designed this very new technology MinION and its variant GridION, PromithION and SmidgION all of them uses the same technology and same platform except SmidgION which can be used with a smart phone at any remote location [5]. Considering the requirement of its low budget and need of no extra gadget as compared to other present technologies which requires high budget and plenty of other equipment MinION will be the future of DNA sequencing [6]. As it has lower cost, easily portable, easy to use and quite precise in performance, this technology has a bright future in developing countries and also in disaster hit areas for diagnostic purpose [7]. This will allow us to investigate different medical cases on the spot [8].

The Centre for Omic Sciences at Islamia College University Peshawar was established in early 2017 with a mission to bring Pakistan on the map of genomics and computational biology (http://genomelab.icp.edu.pk). This centre is on the hunt for the best brains amongst the young scholars to prepare the next generation scientists, innovators and bio-entrepreneurs. The team is striving for developing computational biology in Pakistan since 2011 [9]. The genomics course was proposed in the MPhil and PhD curriculum in 2018 and was approved by the Academic council of the university. It was offered in spring 2019 to the graduate students. State of the art topics have been added in the course including practical sessions on MinION nanopore. Since we can not afford the big sequencers machine neither we have funds to run it, therefore this pocket size sequencer is much better for the students to understand the basics of sequencing.

The course started with the introduction of genomics and computational biology. Students were taught about basics of bioinformatics including databases, alignment tools, primer designing, phylogenetics, protein modelling and docking etc.

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Dr. Muhammad Ilyas (course coordinator) discussed history of genome sequencing, sanger sequencing, shotgun genome sequencing and next generation sequencing. He illustrated the basic working Mechanism of MinION nanopore, sample preparation, loading of sample and reading the output data of the sequencer. He discussed genome sequencing through MinION, and through light on the basic working apparatus of sequencer. Another speaker of the meeting was online from University of Cambridge who discussed the sequencing of Dengue virus using MinION nanopore [10]. He briefly illustrates the use of MinION in sequencing the genome of dengue in remote areas of Indonesia.

Practical session was supervised by the course coordinator, in which around 30 students were given hands on training. Starting from sample preparation, loading of sample, generation of data and its computational analysis. In this section of the meeting the tools used for analysis of output data were discussed and were given practical training on those software that include MinKNOW and Metrichor. MinKNOW is the software that controls the MinION and carries out several core data tasks and can be used to change experimental workflows or parameters [11]. Metrichor is an on-demand, cloud-based, bioinformatics data analysis platform [12]. In addition to all this, the participants were trained in advanced genomics analysis. The raw data obtained was converted to fastq from fast5 format. Bowtie 2 was used to align and assembled against reference genome [13]. The variants were called using SAMtools and the data was prepared for further analysis and interpreted accordingly [14].

Conclusion

In-house seminars and trainings were organized for the students in university. A national training program on using Nanopore sequencer for public health and genomic research has already been planned, including consolidation of research capacity, training, and collaboration across the region. Our training program, establishment of new multidisciplinary research collaborations and the data and approaches we implement from this project will provide a national resource for Pakistani researchers. Through these aims we will establish a domestic sequencing facility, knowledge and basic understanding of the genetic underpinnings of infectious diseases thus creating baseline information required to improve healthcare.

Recommendations

As discussed earlier, by looking at the cost of next generation sequencers the price of MinION nanopore is extremely low. Even a developing country like Pakistan can afford it. So, we would like to recommend to the government of Pakistan that MinION nanopore should be installed in the all higher educational institution all over the country as a teaching tool. This will also help the researchers generate a huge amount of data that will be helpful in diagnostic and in therapeutic purposes.

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